Nokia Customer Care

Service Manual

RM-437; RM-449; RM-450 (Nokia E63)
Mobile Terminal

Part No: (Issue 1)

COMPANY CONFIDENTIAL

Amendment Record Sheet

Amendment No	Date	Inserted By	Comments
Issue 1	11/2008	TSa	

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IMPORTANT

This document is intended for use by qualified service personnel only.

Warnings and cautions

Warnings

- IF THE DEVICE CAN BE INSTALLED IN A VEHICLE, CARE MUST BE TAKEN ON INSTALLATION IN VEHICLES FITTED WITH ELECTRONIC ENGINE MANAGEMENT SYSTEMS AND ANTI-SKID BRAKING SYSTEMS. UNDER CERTAIN FAULT CONDITIONS, EMITTED RF ENERGY CAN AFFECT THEIR OPERATION. IF NECESSARY, CONSULT THE VEHICLE DEALER/ MANUFACTURER TO DETERMINE THE IMMUNITY OF VEHICLE ELECTRONIC SYSTEMS TO RF ENERGY.
- THE PRODUCT MUST NOT BE OPERATED IN AREAS LIKELY TO CONTAIN POTENTIALLY EXPLOSIVE ATMOSPHERES, FOR EXAMPLE, PETROL STATIONS (SERVICE STATIONS), BLASTING AREAS ETC.
- OPERATION OF ANY RADIO TRANSMITTING EQUIPMENT, INCLUDING CELLULAR TELEPHONES, MAY INTERFERE WITH THE FUNCTIONALITY OF INADEQUATELY PROTECTED MEDICAL DEVICES. CONSULT A PHYSICIAN OR THE MANUFACTURER OF THE MEDICAL DEVICE IF YOU HAVE ANY QUESTIONS. OTHER ELECTRONIC EQUIPMENT MAY ALSO BE SUBJECT TO INTERFERENCE.
- BEFORE MAKING ANY TEST CONNECTIONS, MAKE SURE YOU HAVE SWITCHED OFF ALL EQUIPMENT.

Cautions

- Servicing and alignment must be undertaken by qualified personnel only.
- Ensure all work is carried out at an anti-static workstation and that an anti-static wrist strap is worn.
- Ensure solder, wire, or foreign matter does not enter the telephone as damage may result.
- Use only approved components as specified in the parts list.
- Ensure all components, modules, screws and insulators are correctly re-fitted after servicing and alignment.
- Ensure all cables and wires are repositioned correctly.
- Never test a mobile phone WCDMA transmitter with full Tx power, if there is no possibility to perform the measurements in a good performance RF-shielded room. Even low power WCDMA transmitters may disturb nearby WCDMA networks and cause problems to 3G cellular phone communication in a wide area.
- During testing never activate the GSM or WCDMA transmitter without a proper antenna load, otherwise GSM or WCDMA PA may be damaged.

ESD protection

Nokia requires that service points have sufficient ESD protection (against static electricity) when servicing the phone.

Any product of which the covers are removed must be handled with ESD protection. The SIM card can be replaced without ESD protection if the product is otherwise ready for use.

To replace the covers ESD protection must be applied.

All electronic parts of the product are susceptible to ESD. Resistors, too, can be damaged by static electricity discharge.

All ESD sensitive parts must be packed in metallized protective bags during shipping and handling outside any ESD Protected Area (EPA).

Every repair action involving opening the product or handling the product components must be done under ESD protection.

ESD protected spare part packages MUST NOT be opened/closed out of an ESD Protected Area.

For more information and local requirements about ESD protection and ESD Protected Area, contact your local Nokia After Market Services representative.

Care and maintenance

This product is of superior design and craftsmanship and should be treated with care. The suggestions below will help you to fulfil any warranty obligations and to enjoy this product for many years.

- Keep the phone and all its parts and accessories out of the reach of small children.
- Keep the phone dry. Precipitation, humidity and all types of liquids or moisture can contain minerals that will corrode electronic circuits.
- Do not use or store the phone in dusty, dirty areas. Its moving parts can be damaged.
- Do not store the phone in hot areas. High temperatures can shorten the life of electronic devices, damage batteries, and warp or melt certain plastics.
- Do not store the phone in cold areas. When it warms up (to its normal temperature), moisture can form inside, which may damage electronic circuit boards.
- Do not drop, knock or shake the phone. Rough handling can break internal circuit boards.
- Do not use harsh chemicals, cleaning solvents, or strong detergents to clean the phone.
- Do not paint the phone. Paint can clog the moving parts and prevent proper operation.
- Use only the supplied or an approved replacement antenna. Unauthorised antennas, modifications or attachments could damage the phone and may violate regulations governing radio devices.

All of the above suggestions apply equally to the product, battery, charger or any accessory.

Company policy

Our policy is of continuous development; details of all technical modifications will be included with service bulletins.

While every endeavour has been made to ensure the accuracy of this document, some errors may exist. If any errors are found by the reader, NOKIA MOBILE PHONES Business Group should be notified in writing/e-mail.

Please state:

- Title of the Document + Issue Number/Date of publication
- Latest Amendment Number (if applicable)
- Page(s) and/or Figure(s) in error

Please send to:

NOKIA CORPORATION
Nokia Mobile Phones Business Group
Nokia Customer Care
PO Box 86
FIN-24101 SALO
Finland
E-mail: Service.Manuals@nokia.com

Battery information

Note: A new battery's full performance is achieved only after two or three complete charge and discharge cycles!

The battery can be charged and discharged hundreds of times but it will eventually wear out. When the operating time (talk-time and standby time) is noticeably shorter than normal, it is time to buy a new battery.

Use only batteries approved by the phone manufacturer and recharge the battery only with the chargers approved by the manufacturer. Unplug the charger when not in use. Do not leave the battery connected to a charger for longer than a week, since overcharging may shorten its lifetime. If left unused a fully charged battery will discharge itself over time.

Temperature extremes can affect the ability of your battery to charge.

For good operation times with Li-Ion batteries, discharge the battery from time to time by leaving the product switched on until it turns itself off (or by using the battery discharge facility of any approved accessory available for the product). Do not attempt to discharge the battery by any other means.

Use the battery only for its intended purpose.

Never use any charger or battery which is damaged.

Do not short-circuit the battery. Accidental short-circuiting can occur when a metallic object (coin, clip or pen) causes direct connection of the + and - terminals of the battery (metal strips on the battery) for example when you carry a spare battery in your pocket or purse. Short-circuiting the terminals may damage the battery or the connecting object.

Leaving the battery in hot or cold places, such as in a closed car in summer or winter conditions, will reduce the capacity and lifetime of the battery. Always try to keep the battery between 15°C and 25°C (59°F and 77°F). A phone with a hot or cold battery may temporarily not work, even when the battery is fully charged. Batteries' performance is particularly limited in temperatures well below freezing.

Do not dispose of batteries in a fire!

Dispose of batteries according to local regulations (e.g. recycling). Do not dispose as household waste.

Nokia E63 Service Manual Structure

1 General Information
2 Service Tools and Service Concepts
3 BB Troubleshooting
4 RF troubleshooting
5 Camera Module Troubleshooting
6 System Module and User Interface
Glossary

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1 — General Information

NOKIA
E63
SONERA
Th 26/06/2008
Set up e-mail
Set up Internet tel.
No calendar entries today
WLAN scanning off
Menu
Camera

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Product selection

RM-437, RM-449 and RM-450 are dual mode WCDMA/GSM handportable phones. RM-437 supports EGSM850/900/1800/1900 and WCDMA900/2100. RM-449 supports EGSM850/900/1800/1900 and WCDMA850/1900 and RM-450 EGSM850/900/1800/1900 and WCDMA850/2100.

The device has an integrated 2 Mpix FF camera with flash light.

It supports Bluetooth 2.0 + EDR standard.

The device is an MMS (Multimedia Messaging Service) enabled multimedia device. The MMS implementation follows the OMA MMS standard release 1.2.

The device uses Symbian 9.2 (S60) operating system and supports also MIDP Java 2.0, providing a good platform for compelling 3rd party applications.

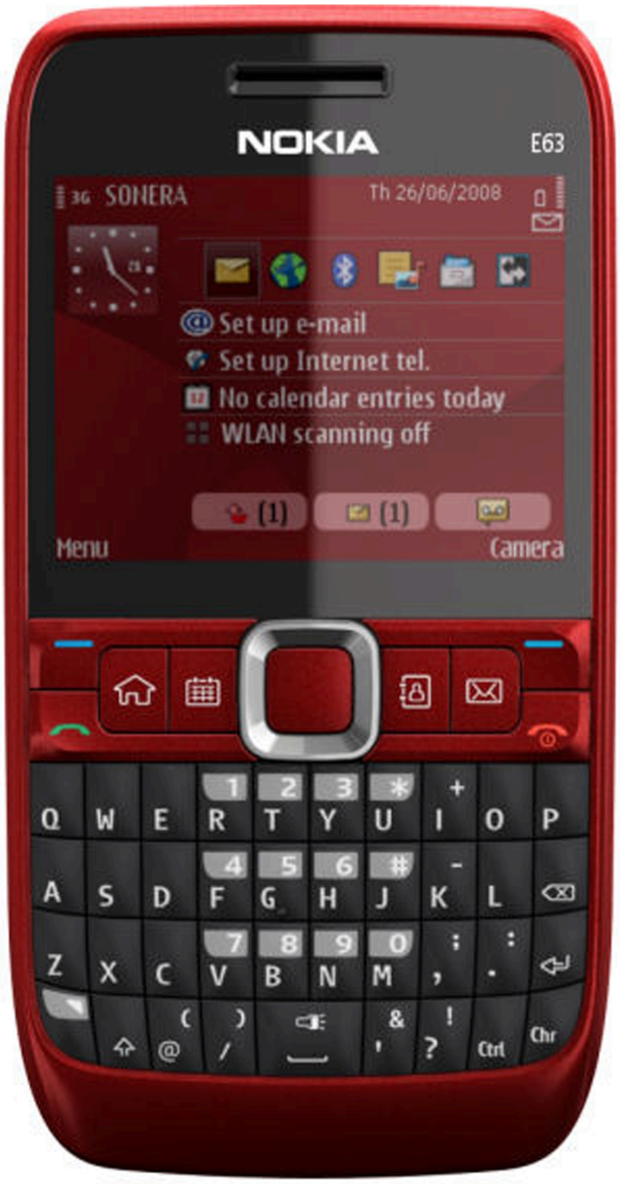

Figure 1 RM-437 product picture

Product features and sales package

Hardware characteristics

Connectivity

- Thin voice monoblock device
- Up to 110 MB of user data memory
- 96 MB RAM
- microSD (hot swap) memory card
- Integrated handsfree speaker
- Internal vibra
- Cameras: 2Mpix FF camera with flash light
- Ambient light sensor
- LED for e-mail, SMS/MMS and missed call indication
- GSM850/900/1800/1900, WCDMA 850/900/1900/2100
- GSM rel. 5
- GPRS/EGPRS (Class A, MSC 32)
- Dual mode transfer MSC11, SAIC rel v1
- Speech codecs AMR, FR and EFR (HR)
- Integrated WLAN (IEEE 802.11g)
- Bluetooth 2.0 + EDR
- Micro USB connector
- 3.5mm Nokia A/V connector with ECI

User Interface & developer platform

- Symbian 9.2
- Nokia Series 60, 3rd edition, feature pack 3.1
- Java: MIDP2.0
- Viewer & Editor font zooming

Display and Keypad

- QVGA 2.36” display (240 x 320), 16M colors
- Nokia Eseries keys (Phonebook, E-mail, Calendar and Home key)
- Power key integrated to End key
- Volume keys integrated to Navi key; works when pressing up/down

Media

- Gallery, MP3 player
- Bluetooth stereo audio
- FM radio and visual radio

Product and module list

Module name	Type code	Notes
System/RF Module	2PV	Main PWB with components.
AVFlex Module	2RV	To connect 3.5mm AV jack to main PWB
UI Flex Module	2PX	Keyboard, light guide and illumination LEDs

Mobile enhancements

Table 1 Car accessories

Enhancement	Type
Mobile holder	CR-108
Holder	HH-17
Holder	HH-12
Car kit	CK-100

Table 2 BT headset

Enhancement	Type
BT headset	BH-606
BT headset	BH-902
BT headset	BH-101

Table 3 BT stereo headset

Enhancement	Type
BT stereo headset	BH-903

Table 4 Memory card

Enhancement	Type
MicroSD card, 256MB	MU-27
MicroSD card, 512MB	MU-28
MicroSD card, 1GB	MU-22
MicroSD card, 2GB	MU-37
MicroSD card, 4GB	MU-41
MicroSD card, 8GB	MU-43

Table 5 Messaging

Enhancement	Type
Digital pen	SU-27W
Wireless keyboard	SU-8W

Table 6 Power

Enhancement	Type
Battery Lion 1500 mAh	BP-4L
Charger adapter	CA-44
Travel charger	AC-8
Mobile charger	DC-4
Micro USB cable	CA-101

Table 7 Headsets

Enhancement	Type
Stereo headset in sales box	WH-102
Basic Stereo headset	HS-43

Technical specifications

Transceiver general specifications

Unit	Dimensions (L x W x T) (mm)	Weight (g)	Volume (cc)
Transceiver with BP-4L Li-Ion battery back	113 x 59 x 13 mm	~120	80

Main RF characteristics for GSM850/900/1800/1900 and WCDMA V (850) and WCDMA I (2100) phones

Parameter	Unit
Cellular system	GSM850, EGSM900, GSM1800/1900, WCDMA V (850) and WCDMA I (2100)
Rx frequency band	GSM850: 869 - 894 MHz
	EGSM900: 925 - 960 MHz
	GSM1800: 1805 - 1880 MHz
	GSM1900: 1930 - 1990 MHz
	WCDMA V (850): 869 - 894 MHz
	WCDMA I (2100): 2110 - 2170 MHz

Parameter	Unit
Tx frequency band	GSM850: 824 - 849 MHz
	EGSM900: 880 - 915 MHz
	GSM1800: 1710 - 1785 MHz
	GSM1900: 1850 - 1910 MHz
	WCDMA V (850): 824 - 849 MHz
	WCDMA I (2100): 1920 - 1980 MHz
Output power	GSM850: +5 ...+33dBm/3.2mW ... 2W
	GSM900: +5 ... +33dBm/3.2mW ... 2W
	GSM1800: +0 ... +30dBm/1.0mW ... 1W
	GSM1900: +0 ... +30dBm/1.0mW ... 1W
	WCDMA V (850): -50 ... +24 dBm/0.01μW ... 251.2mW
	WCDMA I (2100): -50 ... +24 dBm/0.01μW ... 251.2mW
	EDGE850 ja EDGE900: +5...+27 dBm/3.2mW... 501mW
	EDGE1800 ja EDGE1900: +0...+26 dBm/1mW... 400mW
Number of RF channels	GSM850: 124
	GSM900: 174
	GSM1800: 374
	GSM1900: 299
	WCDMA V (850): 108
	WCDMA I (2100): 277
Channel spacing	200 kHz **Note:** NOTE: additional channels at band V have 100 kHz raster
Number of Tx power levels	GSM850: 15
	GSM900: 15
	GSM1800: 16
	GSM1900: 16
	WCDMA V (850): 75
	WCDMA I (2100): 75

Main RF characteristics for GSM850/900/1800/1900 and WCDMA V (850) and WCDMA II (1900) phones

Parameter	Unit
Cellular system	GSM850, EGSM900, GSM1800/1900, WCDMA V (850), WCDMA II (1900)
Rx frequency band	GSM850: 869 - 894MHz
	EGSM900: 925 - 960 MHz
	GSM1800: 1805 - 1880 MHz
	GSM1900: 1930 - 1990 MHz
	WCDMA V (850): 869 - 894 MHz
	WCDMA II (1900): 1930 - 1990 MHz
Tx frequency band	GSM850: 824 - 849MHz
	EGSM900: 880 - 915 MHz
	GSM1800: 1710 - 1785 MHz
	GSM1900: 1850 - 1910 MHz
	WCDMA V (850): 824 - 849 MHz
	WCDMA II (1900):1850 - 1910 MHz
Output power	GSM850: +5 ...+33dBm/3.2mW ... 2W
	GSM900: +5 ... +33dBm/3.2mW ... 2W
	GSM1800: +0 ... +30dBm/1.0mW ... 1W
	GSM1900: +0 ... +30dBm/1.0mW ... 1W
	WCDMA V (850): -50 ... +24 dBm/0.01μW ... 251.2mW
	WCDMA II (1900): -50 ... +24 dBm/0.01μW ... 251.2mW
EDGE output power	EDGE850: +5...+27dBm / 3.2mW...501 mW
	EDGE900: +5...+27dBm / 3.2mW...501 mW
	EDGE1800: +0 ... +26dBm/1.0mW ... 400mW
	EDGE1900:+0 ... +26dBm/1.0mW ... 400mW
Number of RF channels	GSM850: 124
	GSM900: 174
	GSM1800: 374
	GSM1900: 299
	WCDMA V (850): 108
	WCDMA II (1900): 289
Channel spacing	200 kHz **Note:** NOTE: additional channels in WCDMA band II and band V have 100 kHz raster

Parameter	Unit
Number of Tx power levels	GSM850: 15
	GSM900: 15
	GSM1800: 16
	GSM1900: 16
	WCDMA V (850): 75
	WCDMA II (1900): 75

Main RF characteristics for GSM850/900/1800/1900 and WCDMA VIII (900) and WCDMA I (2100) phones

Parameter	Unit
Cellular system	GSM850, EGSM900, GSM1800/1900, WCDMA VIII (900) and WCDMA I (2100)
Rx frequency band	GSM850: 869 - 894 MHz
	EGSM900: 925 - 960 MHz
	GSM1800: 1805 - 1880 MHz
	GSM1900: 1930 - 1990 MHz
	WCDMA VIII (900): 925- 960 MHz
	WCDMA I (2100): 2110 - 2170 MHz
Tx frequency band	GSM850: 824 - 849 MHz
	EGSM900: 880 - 915 MHz
	GSM1800: 1710 - 1785 MHz
	GSM1900: 1850 - 1910 MHz
	WCDMA VIII (900): 880 - 915 MHz
	WCDMA I (2100): 1920 - 1980 MHz
Output power	GSM850: +5 ...+33dBm/3.2mW ... 2W
	GSM900: +5 ... +33dBm/3.2mW ... 2W
	GSM1800: +0 ... +30dBm/1.0mW ... 1W
	GSM1900: +0 ... +30dBm/1.0mW ... 1W
	WCDMA VIII (900): -50 ... +24 dBm/0.01μW ... 251.2mW
	WCDMA I (2100): -50 ... +24 dBm/0.01μW ... 251.2mW
EDGE output power	EDGE850: +5...+27dBm / 3.2mW...501 mW
	EDGE900: +5...+27dBm / 3.2mW...501 mW
	EDGE1800: +0 ... +26dBm/1.0mW ... 400mW
	EDGE1900:+0 ... +26dBm/1.0mW ... 400mW

Parameter	Unit
Number of RF channels	GSM850: 124
	GSM900: 174
	GSM1800: 374
	GSM1900: 299
	WCDMA VIII (900): 152
	WCDMA I (2100): 277
Channel spacing	200 kHz
Number of Tx power levels	GSM850: 15
	GSM900: 15
	GSM1800: 16
	GSM1900: 16
	WCDMA VIII (900): 75
	WCDMA I (2100): 75

Battery endurance

Table 8 GSM

Battery	Capacity (mAh)	Talk time GSM	Stand-by
BP-4L	1500	4,4-11,5h	290-454h

Table 9 WCDMA

Battery	Capacity (mAh)	Talk time WCDMA	Stand-by
BP-4L	1500	3,1-4,7h	290-480h

Charging times

AC-8
2h

2 — Service Tools and Service Concepts

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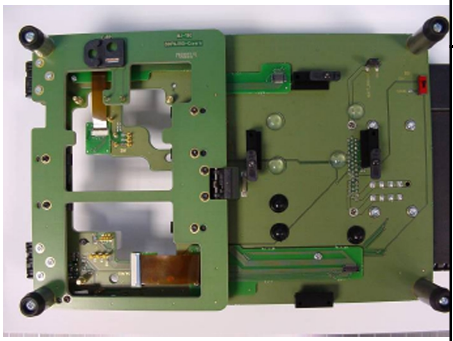
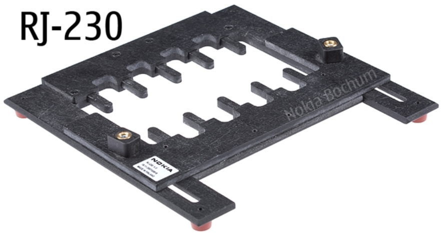
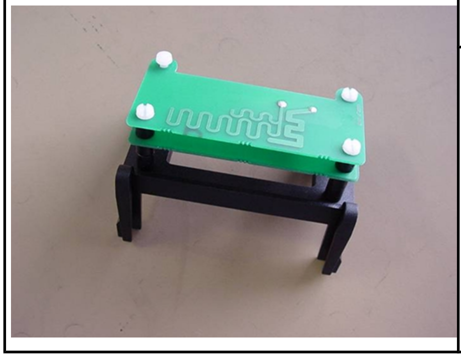
Service tools

Product specific tools

The table below gives a short overview of service devices that can be used for testing, error analysis, and repair of product RM-437; RM-449; RM-450. For the correct use of the service devices, and the best effort of workbench setup, please refer to various concepts.

<table>
<tr><td rowspan="2"> </td><td>FS-76</td><td>Flash adapter</td><td></td></tr>
<tr><td colspan="3">Flash adapter FS-76 is used for phone testing and flashing. FS-76 is used with the generic flash adapter base SS-60/62 and control unit CU-4 or interface adapter SS-46.
When flashing or system testing the phone, the adapter is attached to replace the phone own battery.
All functions (as well as the calibration voltages, current and the protections for over voltages, over current and voltage polarity), are performed by CU-4.
Flash adapter FS-76 main features:
• VBATT supply interface
• USB / FBUS multiplexed interface to the phone</td></tr>
<tr><td rowspan="2"></td><td>MJ-190</td><td>Module jig</td><td></td></tr>
<tr><td colspan="3">MJ-190 can be used for flashing as well as for RF, battery and system testing.
MJ-190 main functions:
• CU-4 interface adapter to phone
• FBUS interface to phone
• UI Interface to phone
• WCDMA and GSM RF-interface
All functions are performed in CU-4 e.g. calibration voltages and currents both all protections (over current, over voltage and voltage polarity).
MJ-190 contains following interfaces to phone:
• VBATT interface
• UI interface containing Display connector
• WCDMA and GSM RF interfaces
• Bluetooth RF interface
• Earpiece interface
• IHF speaker interface
• Microphone interface</td></tr>
</table>

<table>
<tr><td rowspan="2"> </td><td>RJ-230</td><td>Soldering jig</td><td></td></tr>
<tr><td colspan="3">RJ-230 is a soldering jig used for soldering and as a rework jig for the engine module.</td></tr>
<tr><td rowspan="2"></td><td>SA-158</td><td>RF coupler</td><td></td></tr>
<tr><td colspan="3">SA-158 is an RF coupler for WCDMA and GSM RF testing. It is used together with the product-specific flash adapter.</td></tr>
</table>

General tools

The table below gives a short overview of service devices that can be used for testing, error analysis, and repair of product RM-437; RM-449; RM-450. For the correct use of the service devices, and the best effort of workbench setup, please refer to various concepts.

CU-4

NOKIA Bochum

CU-4	Control unit	

CU-4 is a general service tool used with a module jig and/or a flash adapter. It requires an external 12 V power supply.

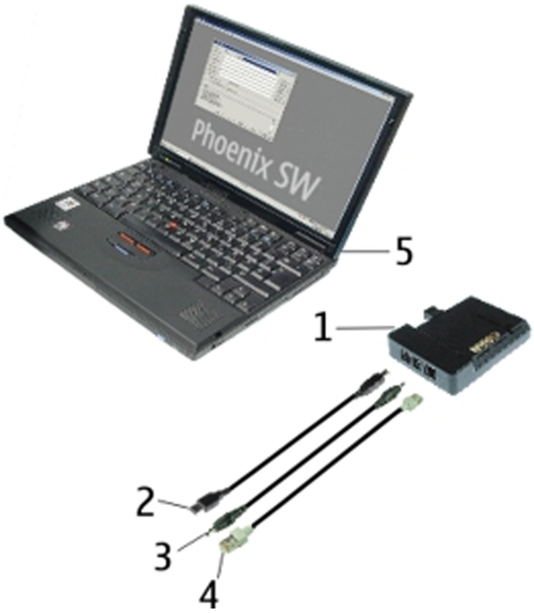
The unit has the following features:

- software controlled via USB
- EM calibration function
- Forwards FBUS/Flashbus traffic to/from terminal
- Forwards USB traffic to/from terminal
- software controlled BSI values
- regulated VBATT voltage
- 2 x USB2.0 connector (Hub)
- FBUS and USB connections supported

When using CU-4, note the special order of connecting cables and other service equipment:

Instructions

1. Connect a service tool (jig, flash adapter) to CU-4.
2. Connect CU-4 to your PC with a USB cable.
3. Connect supply voltage (12 V)
4. Connect an FBUS cable (if necessary).
5. Start Phoenix service software.



Note: Phoenix enables CU-4 regulators via USB when it is started.

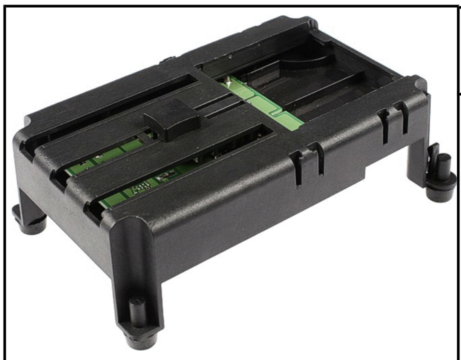
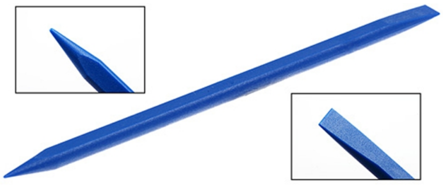
Reconnecting the power supply requires a Phoenix restart.

<table>
<tr><td rowspan="2"> </td><td>FLS-5</td><td>Flash device</td><td></td></tr>
<tr><td colspan="3">FLS-5 is a dongle and flash device incorporated into one package, developed specifically for POS use.
Note: FLS-5 can be used as an alternative to PKD-1.</td></tr>
<tr><td rowspan="2"> </td><td>FPS-10</td><td>Flash prommer</td><td></td></tr>
<tr><td colspan="3">FPS-10 interfaces with:
• PC
• Control unit
• Flash adapter
• Smart card
FPS-10 flash prommer features:
• Flash functionality for BB5 and DCT-4 terminals
• Smart Card reader for SX-2 or SX-4
• USB traffic forwarding
• USB to FBUS/Flashbus conversion
• LAN to FBUS/Flashbus and USB conversion
• Vusb output switchable by PC command
FPS-10 sales package includes:
• FPS-10 prommer
• Power Supply with 5 country specific cords
• USB cable
Note: FPS-21 is substitute FPS-10 if FPS-10 has not been set up.</td></tr>
<tr><td rowspan="2"> </td><td>PK-1</td><td>Software protection key</td><td></td></tr>
<tr><td colspan="3">PK-1 is a hardware protection key with a USB interface. It has the same functionality as the PKD-1 series dongle.
PK-1 is meant for use with a PC that does not have a series interface.
To use this USB dongle for security service functions please register the dongle in the same way as the PKD-1 series dongle.</td></tr>
</table>

<table>
<tr><td rowspan="2">
NOKIA
RF-I/O
CLASS 1
STATUS
BER TEST
FBUS
POWER

</td><td>SB-6</td><td>Bluetooth tester</td><td></td></tr>
<tr><td colspan="3">The SB-6 test box is a generic device to perform Bluetooth bit error rate testing and doing cordless FBUS connection via Bluetooth.</td></tr>
<tr><td rowspan="2"> </td><td>SB-7</td><td>WLAN test box</td><td></td></tr>
<tr><td colspan="3">WLAN test requires defined position for the device.</td></tr>
<tr><td rowspan="2"> </td><td>SRT-6</td><td>Opening tool</td><td></td></tr>
<tr><td colspan="3">SRT-6 is used to open phone covers.</td></tr>
<tr><td rowspan="2">
SS-46
NOKIA Bochum

</td><td>SS-46</td><td>Interface adapter</td><td></td></tr>
<tr><td colspan="3">SS-46 acts as an interface adapter between the flash adapter and FPS-10.</td></tr>
</table>

<table>
<tr><td rowspan="2"></td><td>SS-62</td><td>Generic flash adapter base for BB5</td><td></td></tr>
<tr><td colspan="3">• generic base for flash adapters and couplers
• SS-62 equipped with a clip interlock system
• provides standardised interface towards Control Unit
• provides RF connection using galvanic connector or coupler
• multiplexing between USB and FBUS media, controlled by VUSB</td></tr>
<tr><td rowspan="2"></td><td>SS-93</td><td>Opening tool</td><td></td></tr>
<tr><td colspan="3">SS-93 is used for opening JAE connectors.</td></tr>
<tr><td rowspan="2">

SX-4
NOKIA
NOKIA Bochum

</td><td>SX-4</td><td>Smart card</td><td></td></tr>
<tr><td colspan="3">SX-4 is a BB5 security device used to protect critical features in tuning and testing.
SX-4 is also needed together with FPS-10 when DCT-4 phones are flashed.</td></tr>
</table>

Cables

The table below gives a short overview of service devices that can be used for testing, error analysis, and repair of product RM-437; RM-449; RM-450. For the correct use of the service devices, and the best effort of workbench setup, please refer to various concepts.

<table>
<tr><td rowspan="2">

CA-101
100cm

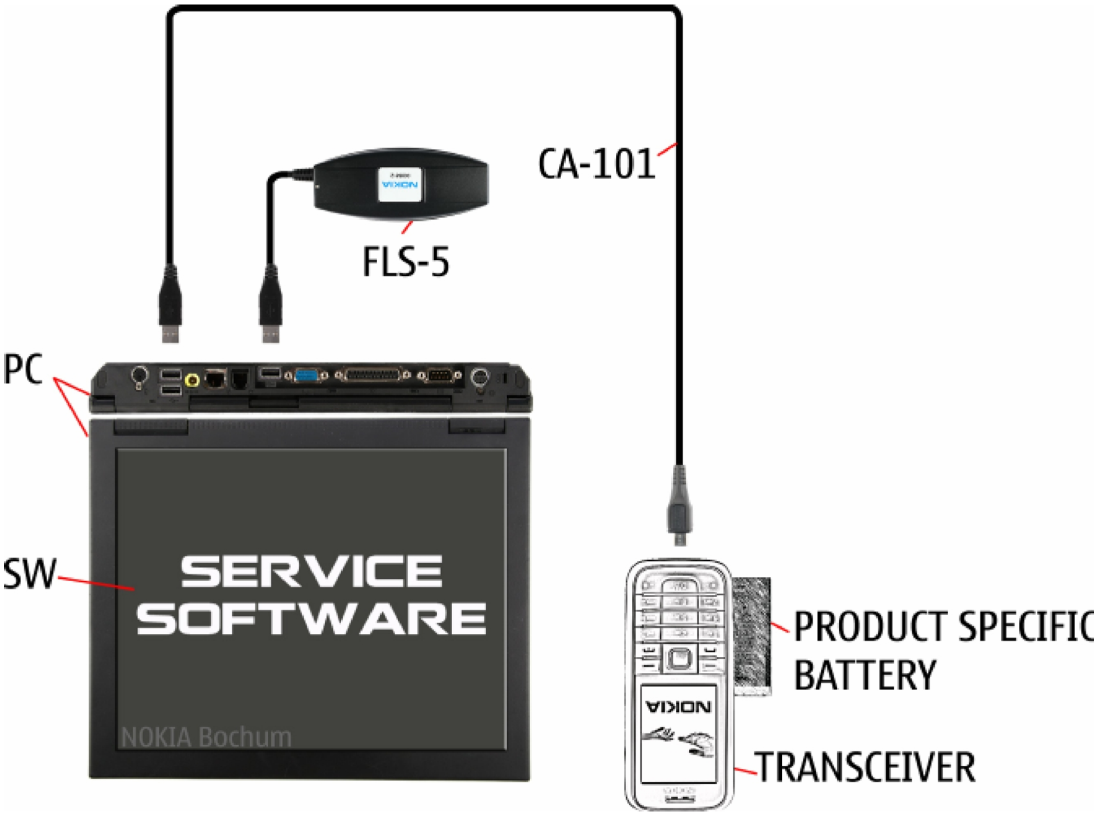
</td><td>CA-101</td><td>Micro USB cable</td><td></td></tr>
<tr><td colspan="3">The CA-101 is a USB-to-microUSB data cable that allows connections between the PC and the phone.</td></tr>
</table>

	CA-31D	USB cable	
	The CA-31D USB cable is used to connect FPS-10 or FPS-11 to a PC. It is included in the FPS-10 and FPS-11 sales packages.		
	CA-35S	Power cable	
	CA-35S is a power cable for connecting, for example, the FPS-10 flash prommer to the Point-Of-Sales (POS) flash adapter.		
	CA-53	USB connectivity cable	
	USB to system connector cable.		

<table>
<tr><td rowspan="2"> </td><td>PCS-1</td><td>Power cable</td><td></td></tr>
<tr><td colspan="3">The PCS-1 power cable (DC) is used with a docking station, a module jig or a control unit to supply a controlled voltage.</td></tr>
<tr><td rowspan="2"> </td><td>XCS-4</td><td>Modular cable</td><td></td></tr>
<tr><td colspan="3">XCS-4 is a shielded (one specially shielded conductor) modular cable for flashing and service purposes.</td></tr>
<tr><td rowspan="2"> </td><td>XRS-6</td><td>RF cable</td><td></td></tr>
<tr><td colspan="3">The RF cable is used to connect, for example, a module repair jig to the RF measurement equipment.
SMA to N-Connector approximately 610 mm.
Attenuation for:
• GSM850/900: 0.3+-0.1 dB
• GSM1800/1900: 0.5+-0.1 dB
• WLAN: 0.6+-0.1dB</td></tr>
</table>

Service concepts

POS (Point of Sale) flash concept


CA-101
FLS-5
PC
SW
SERVICE SOFTWARE
NOKIA Bochum
PRODUCT SPECIFIC BATTERY
TRANSCEIVER

Type	Description
Product specific tools	
BP-4L	Battery
Other tools	
FLS-5	POS flash dongle
	PC with Phoenix service software
Cables	
CA-101	Micro USB cable

Module jig service concept

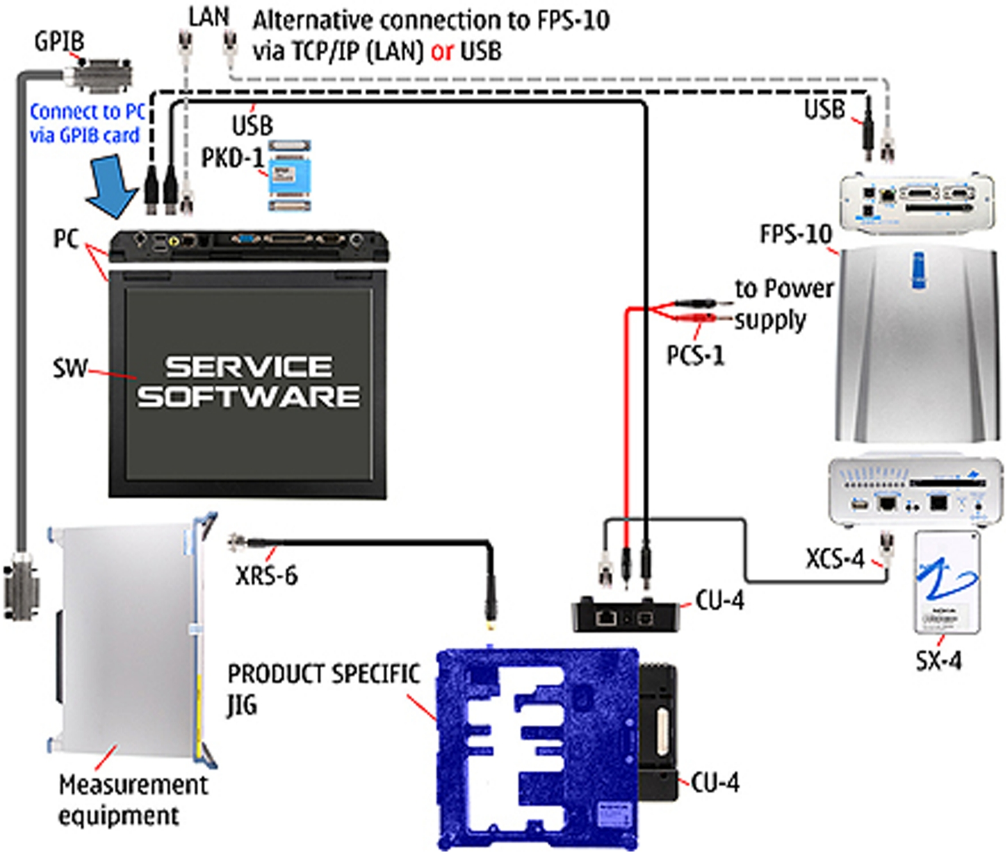

GPIB
LAN
Alternative connection to FPS-10
via TCP/IP (LAN) or USB
Connect to PC
via GPIB card
USB
PKD-1
USB
PC
FPS-10
to Power
supply
PCS-1
SW
SERVICE
SOFTWARE
XRS-6
XCS-4
CU-4
SX-4
PRODUCT SPECIFIC
JIG
CU-4
Measurement
equipment

Figure 2 Module jig service concept

Type	Description
Phone specific devices	
MJ-190	Module jig
Other devices	
CU-4	Control unit
FPS-10	Flash prommer box
PK-1	SW security device
SX-4	Smart card
	PC with VPOS and Phoenix service software
	Measurement equipment
Cables	
PCS-1	DC power cable
XCS-4	Modular cable
XRF-1	RF cable
	USB cable

Type	Description
	GPIB control cable

Service concept for RF testing and RF/BB tuning

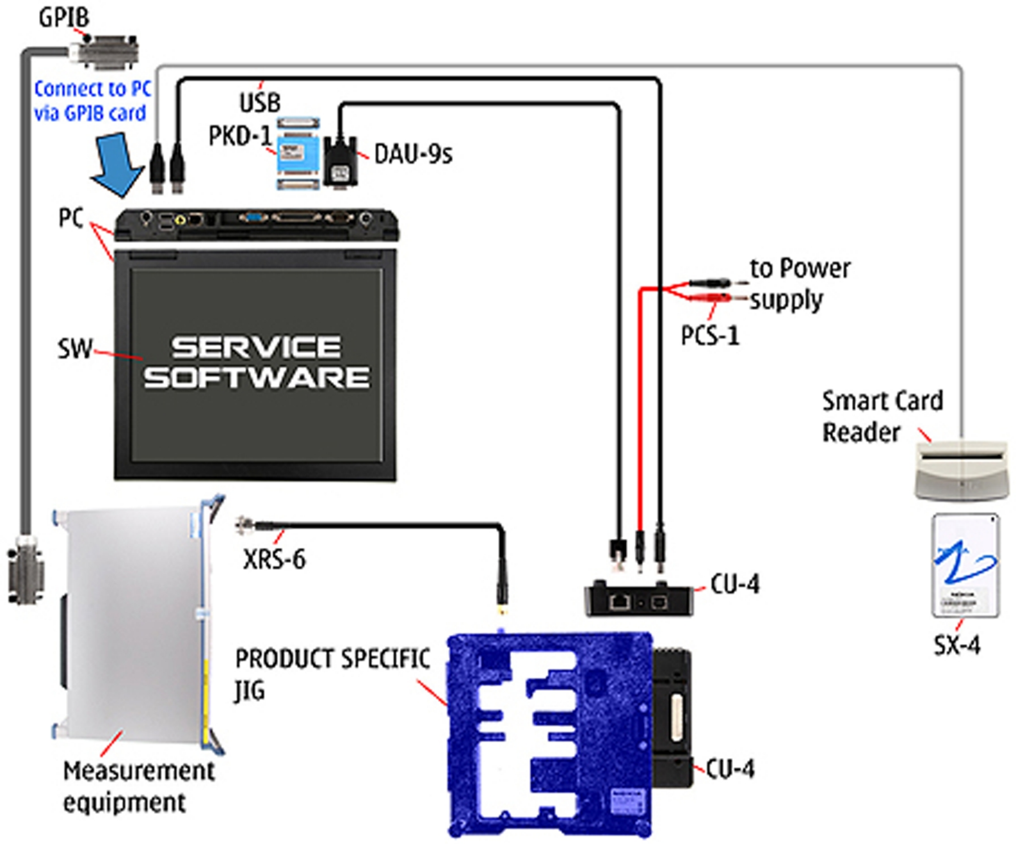

GPIB
Connect to PC via GPIB card
USB
PKD-1
DAU-9s
PC
SW
SERVICE SOFTWARE
to Power supply
PCS-1
Smart Card Reader
XRS-6
CU-4
SX-4
PRODUCT SPECIFIC JIG
CU-4
Measurement equipment

Figure 3 Service concept for RF testing and RF/BB tuning

Type	Description
Product specific devices	
MJ-190	Module jig
Other devices	
CU-4	Control unit
PK-1/PKD-1	SW security device
SX-4	Smart card
	Measurement equipment
	Smart card reader
	PC with Phoenix service software
Cables	
DAU-9S	MBUS cable
PCS-1	DC power cable

Type	Description
XRS-6	RF cable
	GPIB control cable
	USB cable

Flash concept with FPS-10

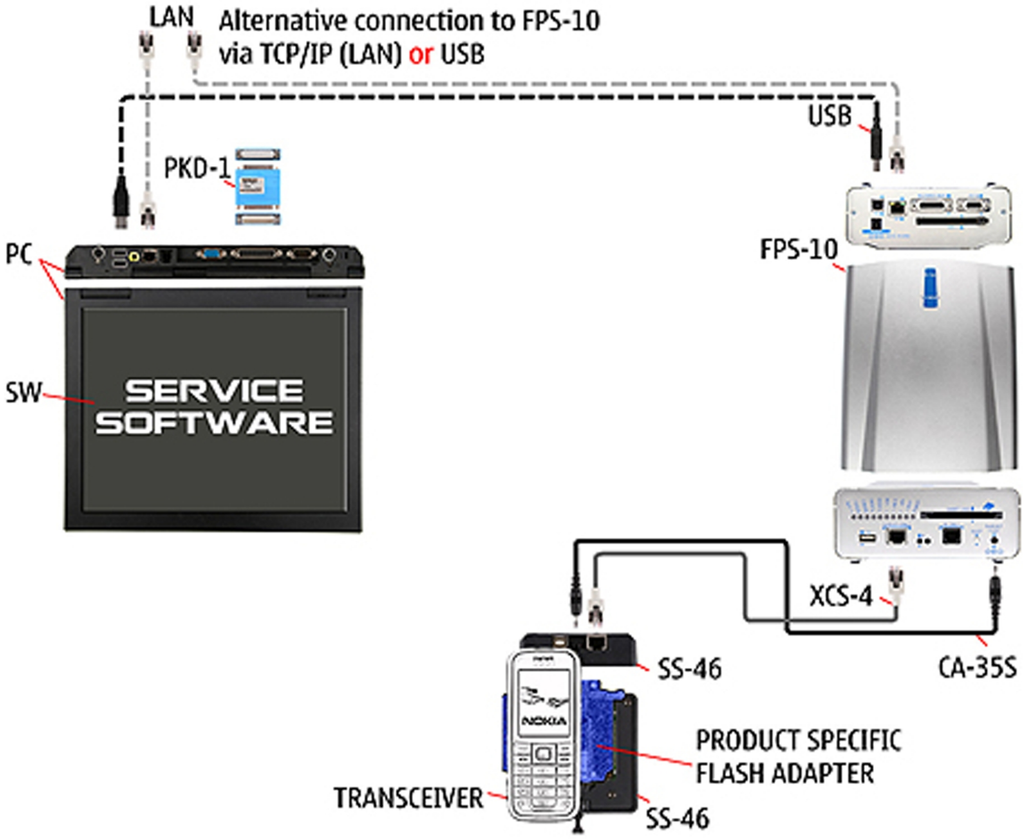

LAN
Alternative connection to FPS-10
via TCP/IP (LAN) or USB
USB
PKD-1
PC
FPS-10
SW
SERVICE
SOFTWARE
XCS-4
SS-46
CA-35S
PRODUCT SPECIFIC
FLASH ADAPTER
TRANSCEIVER
SS-46

Figure 4 Basic flash concept with FPS-10

Type	Description
Product specific devices	
FS-76	Flash adapter
Other devices	
FPS-10	Flash prommer box
PKD-1/PK-1	SW security device
SS-46	Interface adapter
	PC with Phoenix service software
Cables	
XCS-4	Modular cable
CA-35S	Power cable

Type	Description
	USB cable

RF testing concept with RF coupler

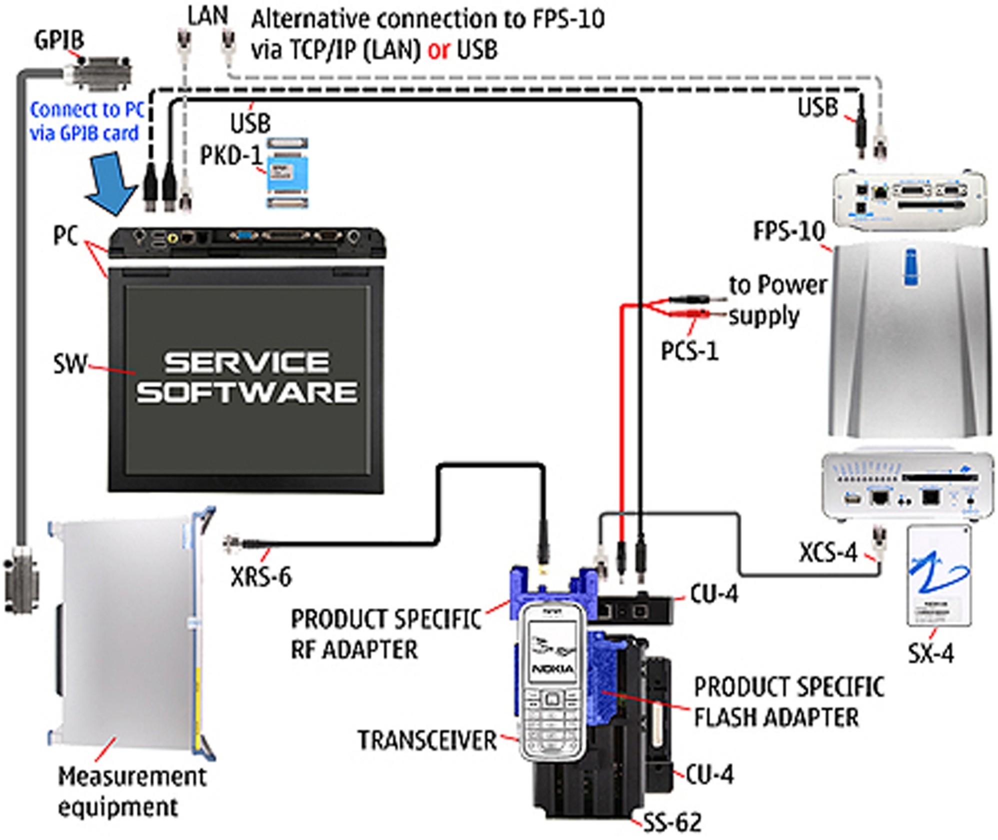

LAN
Alternative connection to FPS-10
via TCP/IP (LAN) or USB
GPIB
Connect to PC
via GPIB card
USB
PKD-1
USB
FPS-10
PC
to Power
supply
PCS-1
SW
SERVICE
SOFTWARE
XCS-4
XRS-6
CU-4
PRODUCT SPECIFIC
RF ADAPTER
SX-4
PRODUCT SPECIFIC
FLASH ADAPTER
TRANSCEIVER
CU-4
Measurement
equipment
SS-62

Figure 5 RF testing concept with RF coupler

Type	Description
Product specific devices	
FS-76	Flash adapter
SA-158	RF coupler
Other devices	
CU-4	Control unit
SX-4	Smart card
FPS-10	Flash prommer box
PKD-1/PK-1	SW security device
SS-62	Flash adapter base
	Measurement equipment
	PC with Phoenix service software
Cables	
PCS-1	Power cable

Type	Description
XCS-4	Modular cable
XRS-6	RF cable
	GPIB control cable
	USB cable

CU-4 flash concept with FPS-10

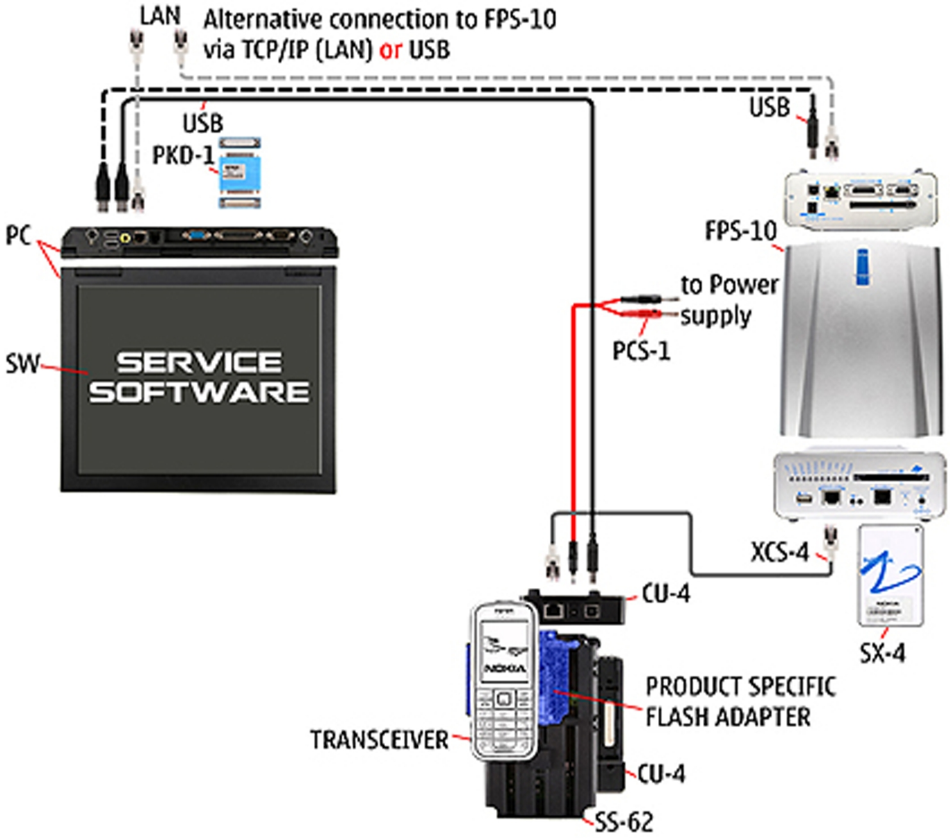

LAN
Alternative connection to FPS-10
via TCP/IP (LAN) or USB
USB
USB
PKD-1
PC
SW
SERVICE
SOFTWARE
FPS-10
to Power
supply
PCS-1
XCS-4
CU-4
SX-4
PRODUCT SPECIFIC
FLASH ADAPTER
TRANSCEIVER
CU-4
SS-62

Figure 6 CU-4 flash concept with FPS-10

Type	Description
Product specific devices	
FS-76	Flash adapter
Other devices	
CU-4	Control unit
FPS-10	Flash prommer box
PKD-1/PK-1	SW security device
SS-62	Flash adapter base
SX-4	Smart card
	PC with Phoenix service software
Cables	

Type	Description
PCS-1	Power cable
XCS-4	Modular cable
	Standard USB cable
	USB cable

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3 — BB Troubleshooting

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Figure 12 Single-ended output waveform of the Ext_in_Ext_out loop. 3–35
Figure 13 Single-ended output waveform of the Digital_stereo_microphone_in_Ext_out loop. 3–35

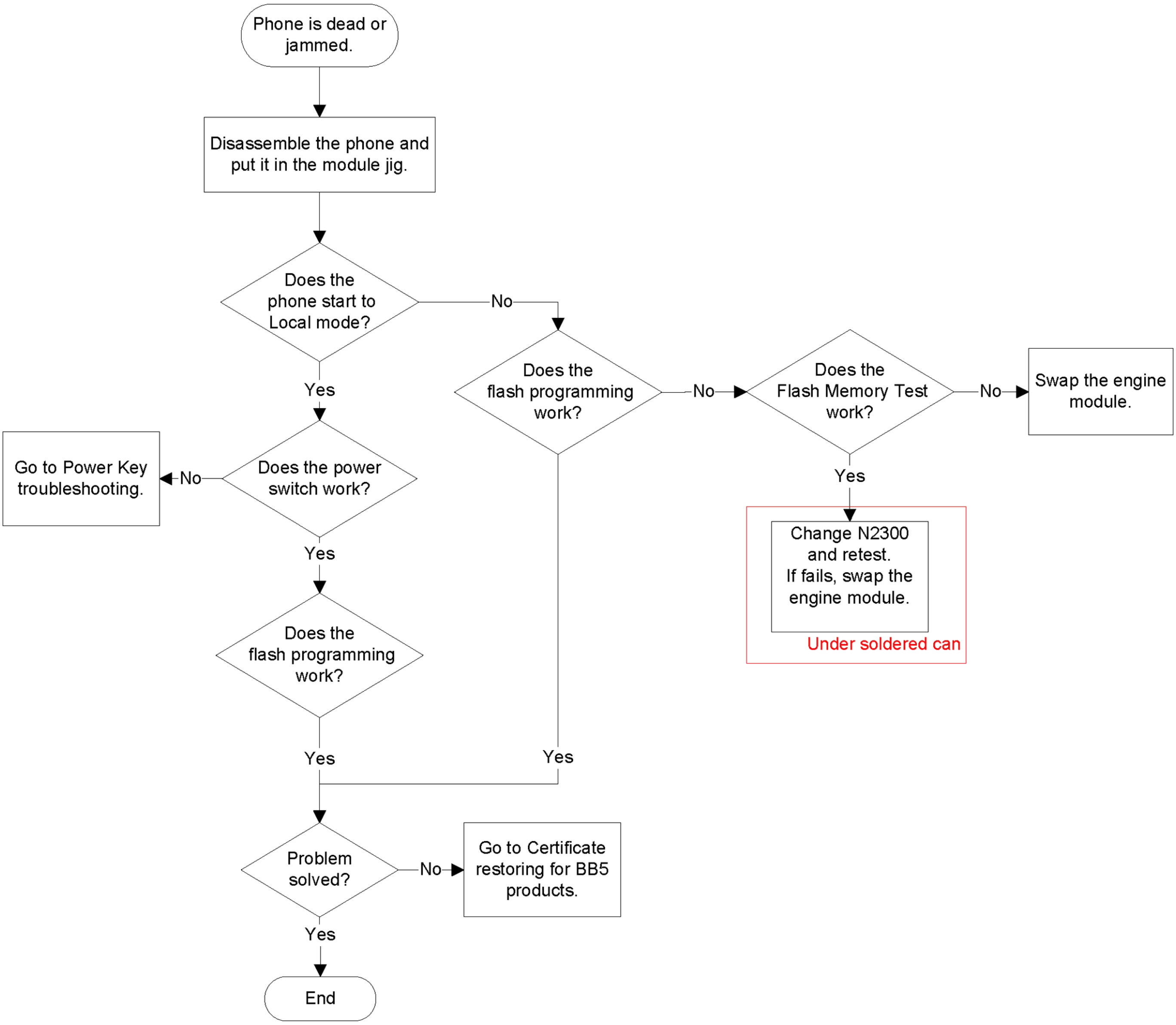
Troubleshooting overview

For practical reasons, troubleshooting is divided into two sections:

- Baseband troubleshooting, including FM radio and Bluetooth.
- RF troubleshooting

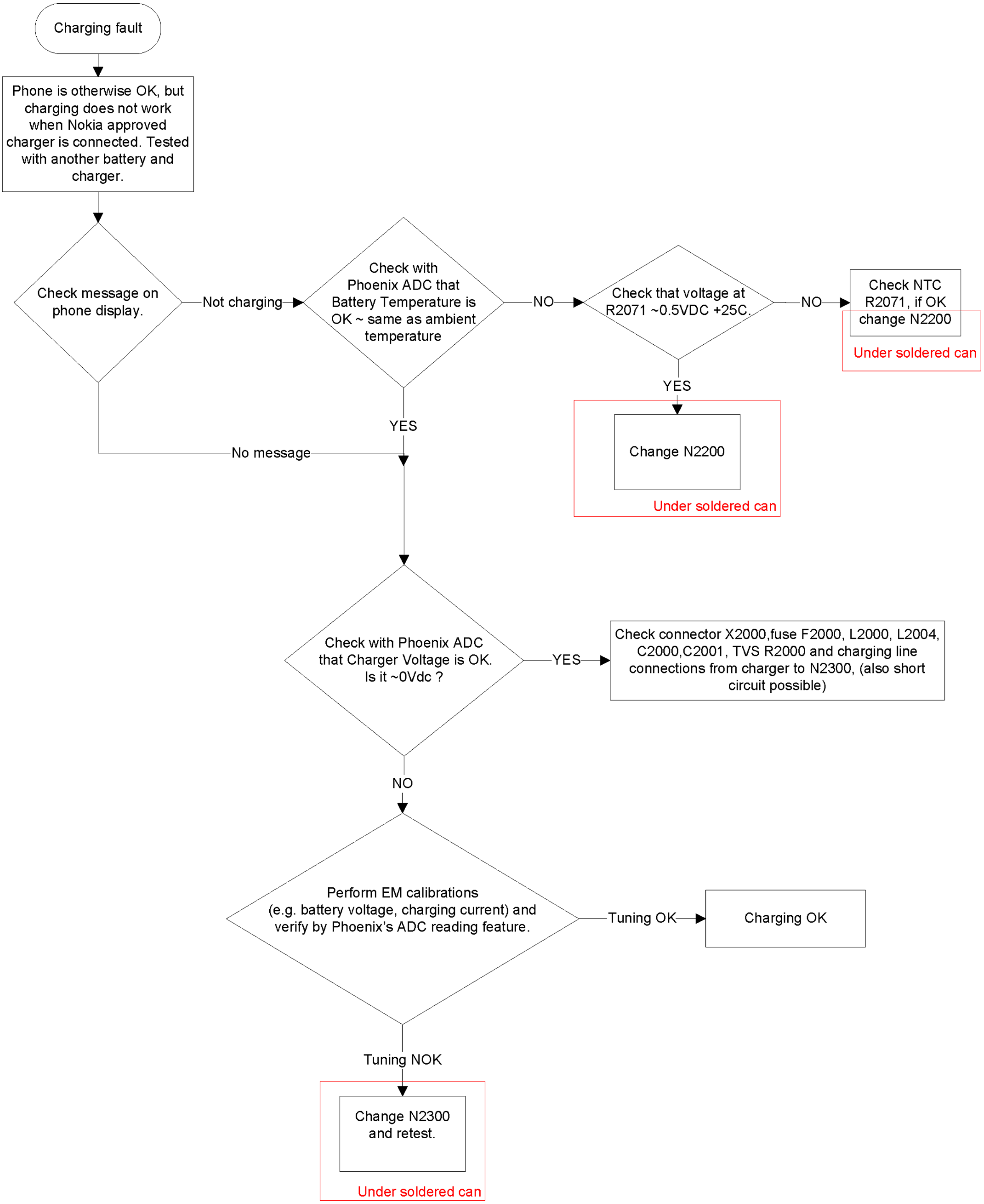
Dead or jammed device troubleshooting

Troubleshooting flow


Phone is dead or jammed.
Disassemble the phone and put it in the module jig.
Does the phone start to Local mode?
No
Yes
Does the flash programming work?
No
Does the Flash Memory Test work?
No
Swap the engine module.
Yes
Change N2300 and retest. If fails, swap the engine module.
Under soldered can
Go to Power Key troubleshooting.
No
Does the power switch work?
Yes
Does the flash programming work?
Yes
Yes
Problem solved?
No
Go to Certificate restoring for BB5 products.
Yes
End

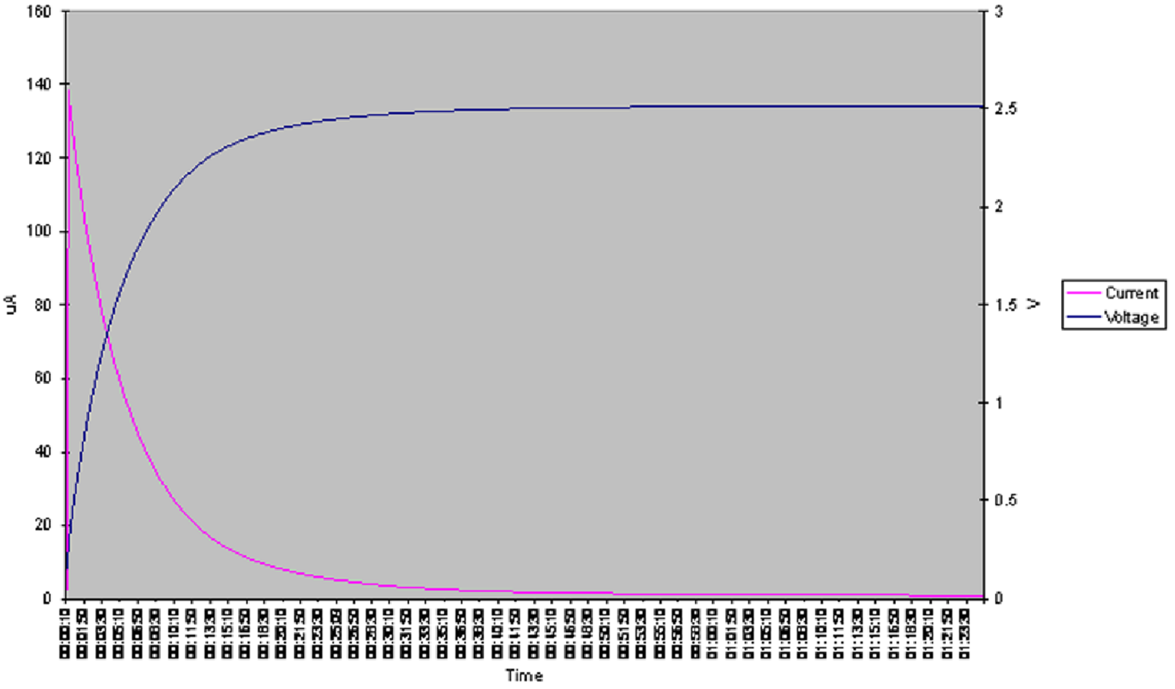
Charging troubleshooting

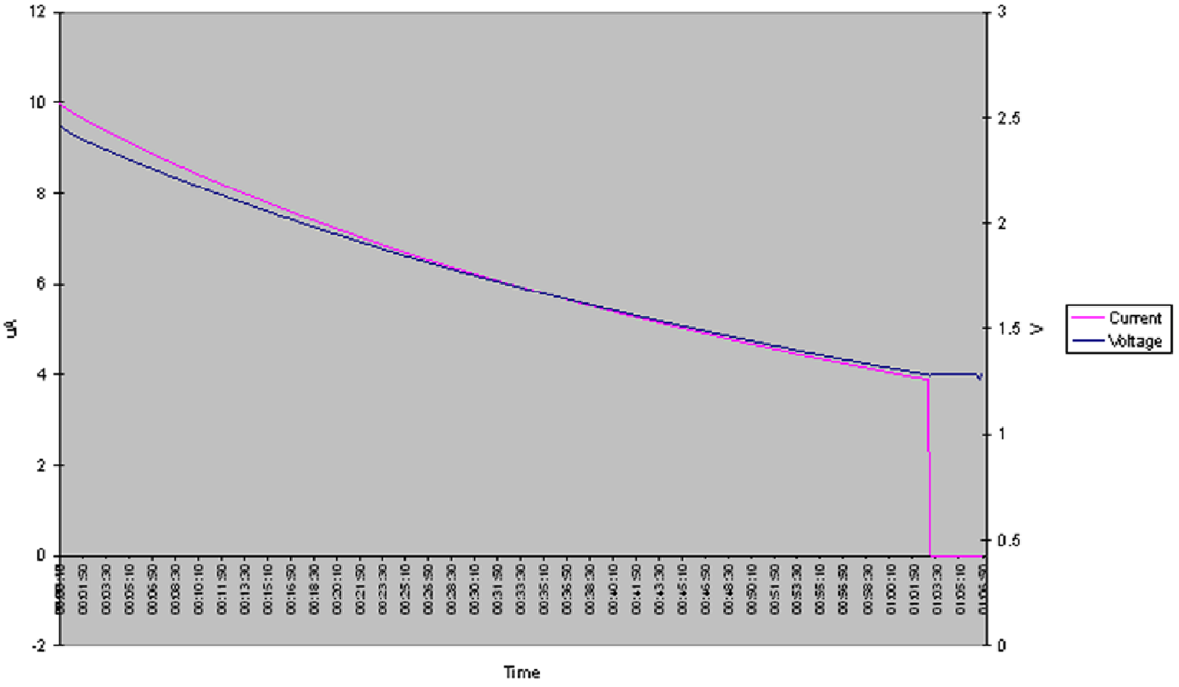
Troubleshooting flow


Charging fault
Phone is otherwise OK, but charging does not work when Nokia approved charger is connected. Tested with another battery and charger.
Check message on phone display.
Not charging
Check with Phoenix ADC that Battery Temperature is OK ~ same as ambient temperature
NO
Check that voltage at R2071 ~0.5VDC +25C.
NO
Check NTC R2071, if OK change N2200
Under soldered can
YES
Change N2200
Under soldered can
YES
No message
Check with Phoenix ADC that Charger Voltage is OK. Is it ~0Vdc ?
YES
Check connector X2000,fuse F2000, L2000, L2004, C2000,C2001, TVS R2000 and charging line connections from charger to N2300, (also short circuit possible)
NO
Perform EM calibrations (e.g. battery voltage, charging current) and verify by Phoenix's ADC reading feature.
Tuning OK
Charging OK
Tuning NOK
Change N2300 and retest.
Under soldered can

Backup battery troubleshooting

Verify that the backup battery G2200 is empty (U<1V). Switch the phone on. Measure voltage of the battery when the main battery is connected to the phone and the phone is switched on. Wait a few minutes and monitor that the backup battery voltage rises. Switch off the phone, disconnect the main battery and monitor that the voltage of the backup battery decreases. Normal behaviour of the voltage is described in the figures below:

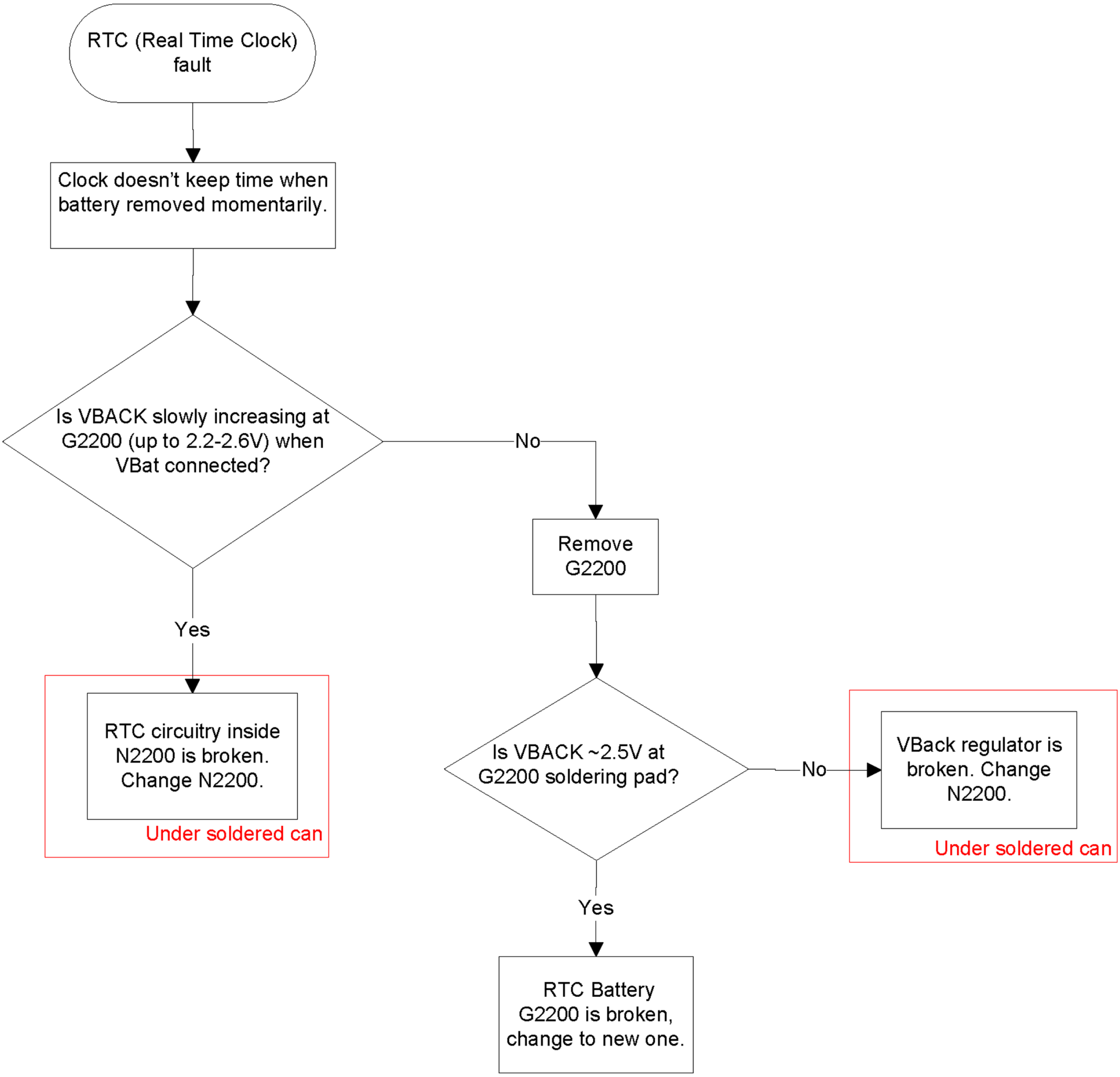




If the voltage rises and falls quickly, check the back-up battery G2200 contacts for loose soldering or short-circuit, and repair or change G2200 if necessary. If the voltage stays ~0V, check resistance VBACK against GND. If there is no shortcircuit, AVILMA N2200 is faulty. Replace N2200.

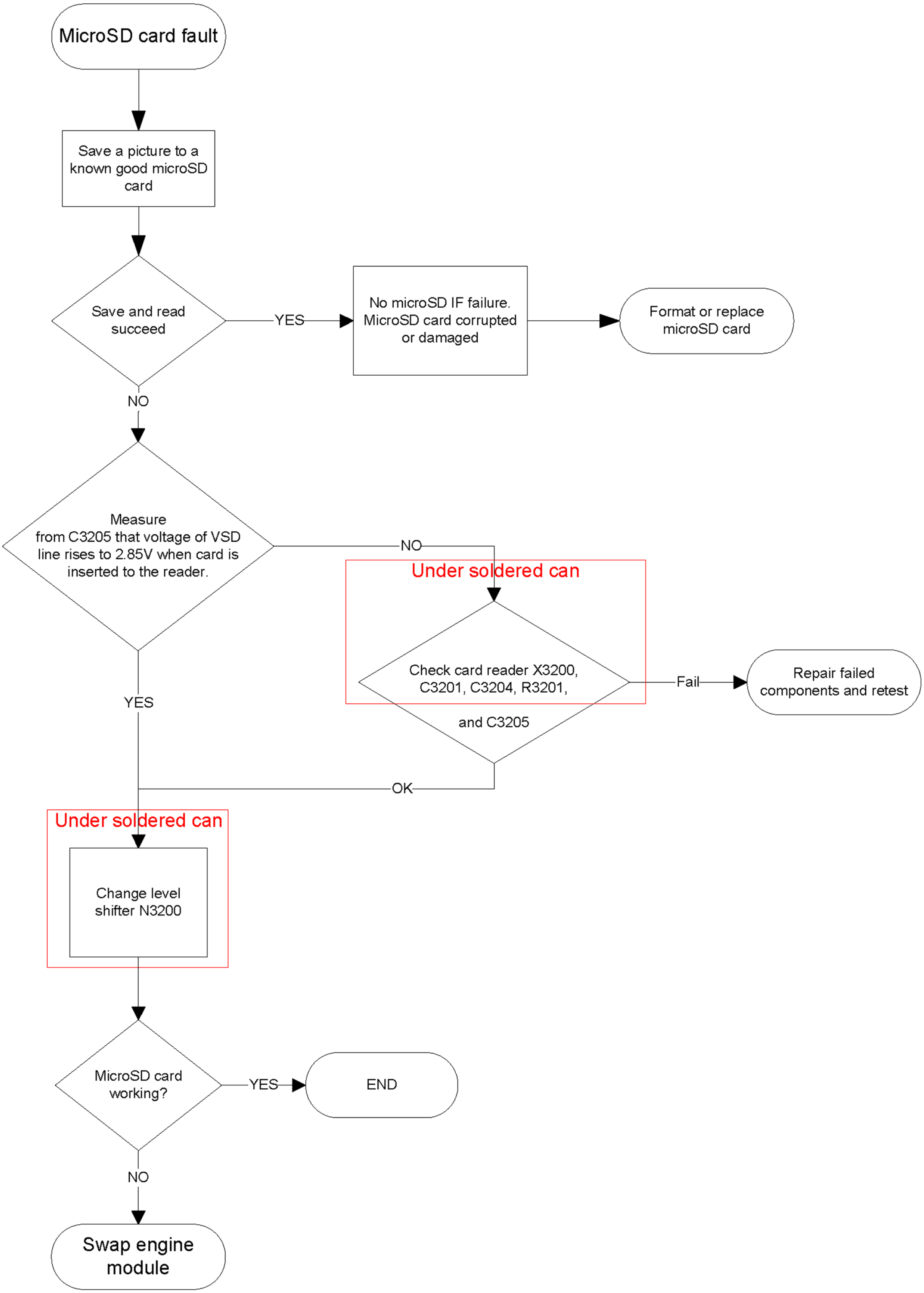
Backup battery troubleshooting

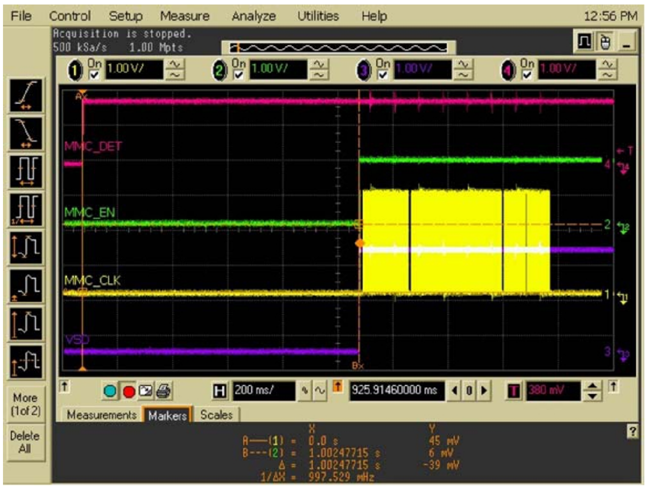
Troubleshooting flow


RTC (Real Time Clock) fault
Clock doesn't keep time when battery removed momentarily.
Is VBACK slowly increasing at G2200 (up to 2.2-2.6V) when VBat connected?
No
Remove G2200
Yes
RTC circuitry inside N2200 is broken. Change N2200.
Under soldered can
Is VBACK ~2.5V at G2200 soldering pad?
No
VBack regulator is broken. Change N2200.
Under soldered can
Yes
RTC Battery G2200 is broken, change to new one.

MicroSD card troubleshooting

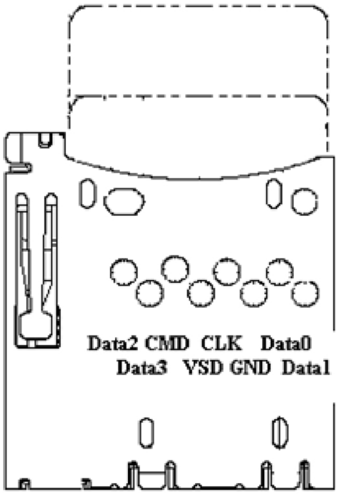
Troubleshooting flow


MicroSD card fault
Save a picture to a known good microSD card
Save and read succeed
YES
No microSD IF failure. MicroSD card corrupted or damaged
Format or replace microSD card
NO
Measure from C3205 that voltage of VSD line rises to 2.85V when card is inserted to the reader.
NO
Under soldered can
Check card reader X3200, C3201, C3204, R3201, and C3205
Fail
Repair failed components and retest
YES
OK
Under soldered can
Change level shifter N3200
MicroSD card working?
YES
END
NO
Swap engine module

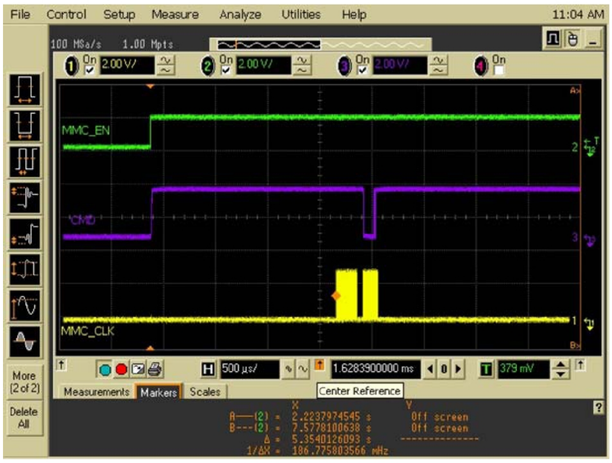

File Control Setup Measure Analyze Utilities Help
12:56 PM
Acquisition is stopped.
500 kSa/s 1.00 Mpts
1.00 V/
1.00 V/
1.00 V/
1.00 V/
MMC_DET
MMC_EN
MMC_CLK
VSD
200 ms/
925.91460000 ms
380 mV
More (1 of 2)
Delete All
Measurements
Markers
Scales

```
               X                 Y
A——(1) =   0.0 s              45 mV
B---(2) =  1.00247715 s        6 mV
      Δ =  1.00247715 s      -39 mV
   1/ΔX =  997.529 mHz
```

MicroSD interface signals timing when door is closed.

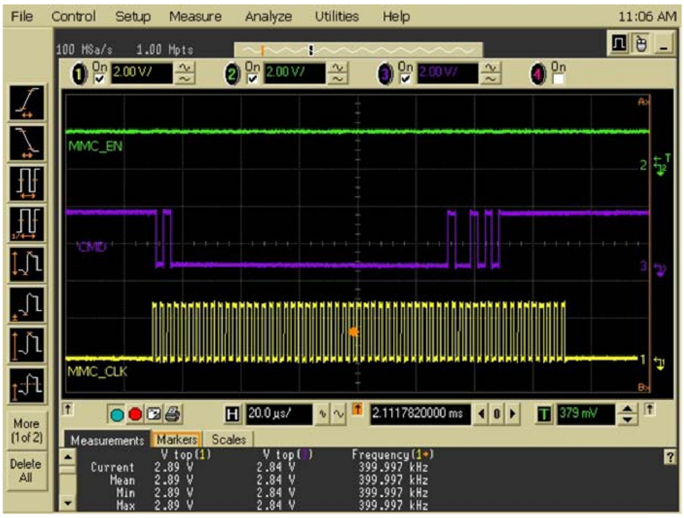

Data2 CMD CLK Data0
Data3 VSD GND Data1

MicroSD connector


File Control Setup Measure Analyze Utilities Help
11:04 AM
100 MSa/s 1.00 Mpts
2.00 V/
2.00 V/
2.00 V/
MMC_EN
CMD
MMC_CLK
500 µs/
1.6283900000 ms
379 mV
More (2 of 2)
Delete All
Measurements
Markers
Scales
Center Reference

```
               X                    Y
A——(2) =   2.2237974545 s      Off screen
B---(2) =  7.5778100638 s      Off screen
      Δ =  5.3540126093 s     --------------
   1/ΔX =  186.775803566 mHz
```

CLK and CMD signals during card initiation when card is not inserted. Measured from the microSD connector.

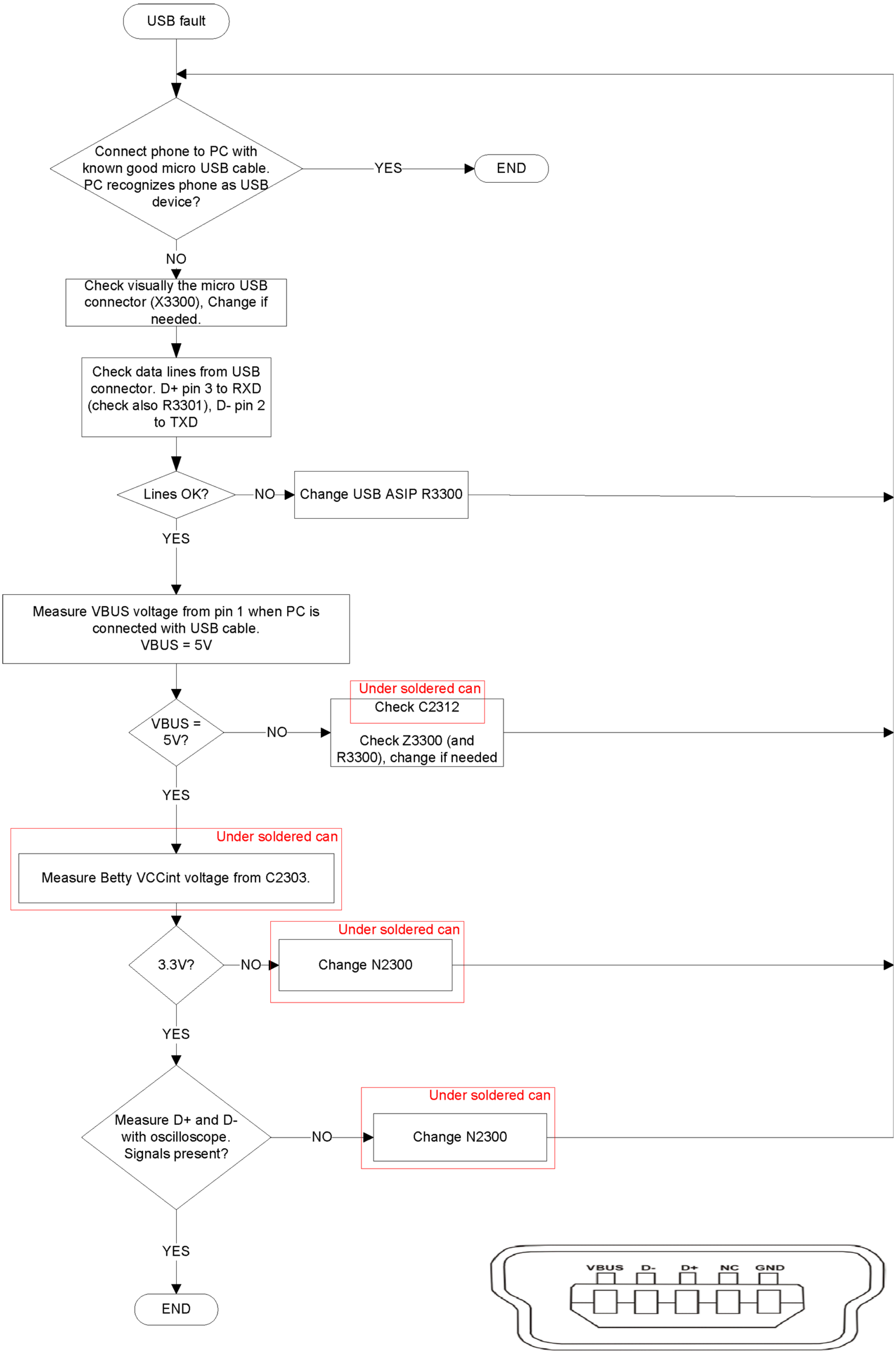

File Control Setup Measure Analyze Utilities Help
11:06 AM
100 MSa/s 1.00 Mpts
2.00 V/
2.00 V/
2.00 V/
MMC_EN
CMD
MMC_CLK
20.0 µs/
2.1117820000 ms
379 mV
More (1 of 2)
Delete All
Measurements
Markers
Scales

```
          V top(1)     V top(3)     Frequency(1+)
Current   2.89 V       2.84 V       399.997 kHz
   Mean   2.89 V       2.84 V       399.997 kHz
    Min   2.89 V       2.84 V       399.997 kHz
    Max   2.89 V       2.84 V       399.997 kHz
```

CLK and CMD signals during card initiaisation when card is not inserted. Measured from the microSD connector

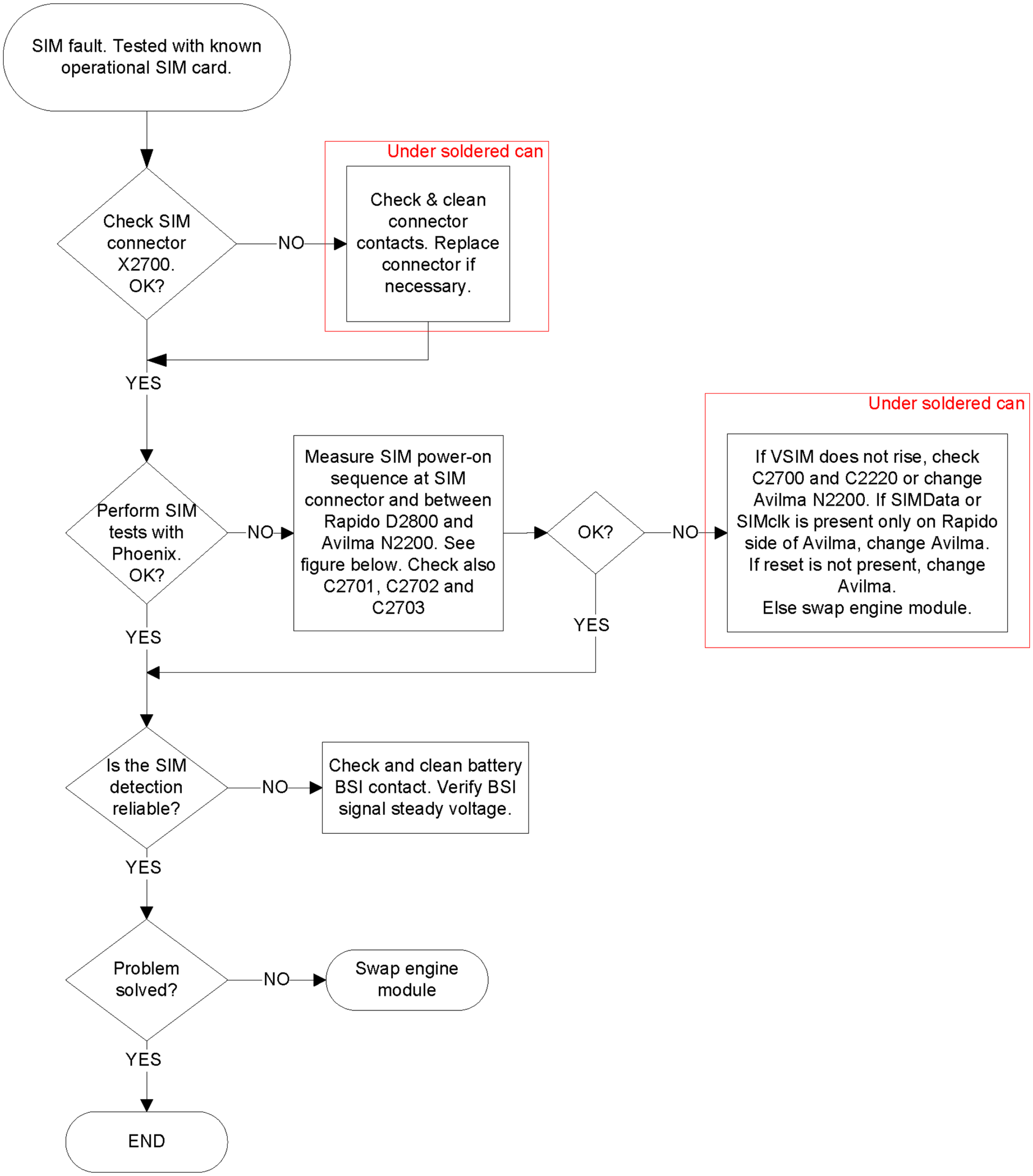
Micro USB troubleshooting

Troubleshooting flow


USB fault
Connect phone to PC with known good micro USB cable. PC recognizes phone as USB device?
YES
END
NO
Check visually the micro USB connector (X3300), Change if needed.
Check data lines from USB connector. D+ pin 3 to RXD (check also R3301), D- pin 2 to TXD
Lines OK?
NO
Change USB ASIP R3300
YES
Measure VBUS voltage from pin 1 when PC is connected with USB cable.
VBUS = 5V
VBUS = 5V?
NO
Under soldered can
Check C2312
Check Z3300 (and R3300), change if needed
YES
Under soldered can
Measure Betty VCCint voltage from C2303.
3.3V?
NO
Under soldered can
Change N2300
YES
Measure D+ and D- with oscilloscope. Signals present?
NO
Under soldered can
Change N2300
YES
END
VBUS
D-
D+
NC
GND

SIM card troubleshooting

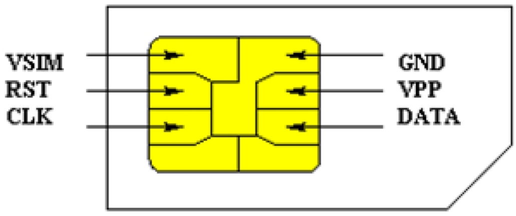
Troubleshooting flow


SIM fault. Tested with known operational SIM card.
Check SIM connector X2700. OK?
NO
Under soldered can
Check & clean connector contacts. Replace connector if necessary.
YES
Perform SIM tests with Phoenix. OK?
NO
Measure SIM power-on sequence at SIM connector and between Rapido D2800 and Avilma N2200. See figure below. Check also C2701, C2702 and C2703
OK?
NO
Under soldered can
If VSIM does not rise, check C2700 and C2220 or change Avilma N2200. If SIMData or SIMclk is present only on Rapido side of Avilma, change Avilma. If reset is not present, change Avilma.
Else swap engine module.
YES
YES
Is the SIM detection reliable?
NO
Check and clean battery BSI contact. Verify BSI signal steady voltage.
YES
Problem solved?
NO
Swap engine module
YES
END

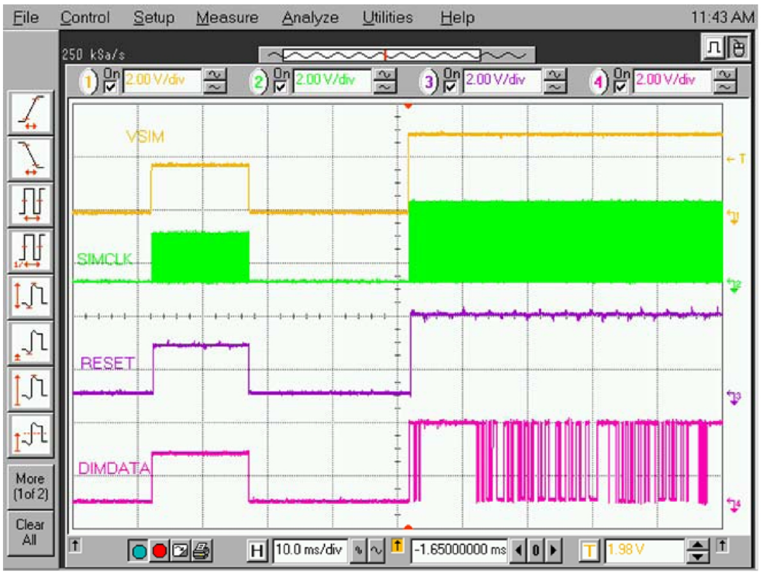
SIM power-on sequence

Testpoints between
Rapido and AVILMA
J2213 = SIMCLK
J2214 = SIMDATA
J2215 = SIMIOC

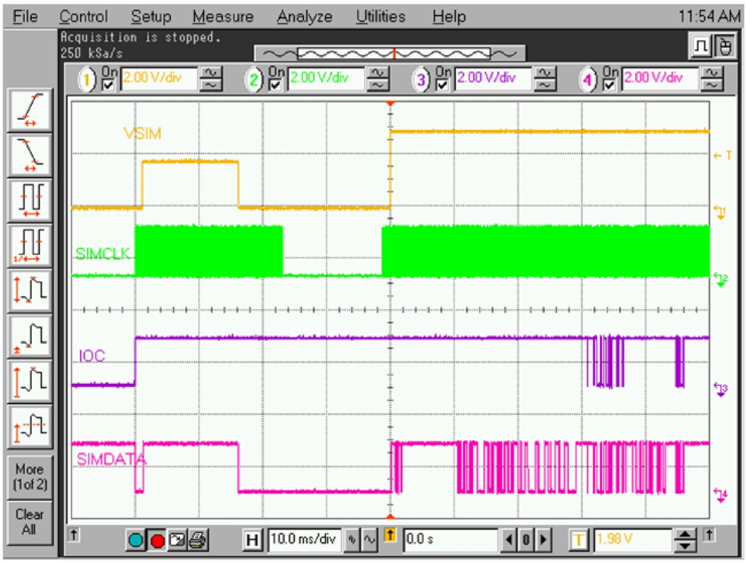
Fsimclk = 3.2MHz


VSIM
RST
CLK
GND
VPP
DATA

SIM contacts


File
Control
Setup
Measure
Analyze
Utilities
Help
11:43 AM
250 kSa/s
1 On 2.00 V/div
2 On 2.00 V/div
3 On 2.00 V/div
4 On 2.00 V/div
VSIM
SIMCLK
RESET
DIMDATA
More (1of 2)
Clear All
H 10.0 ms/div
-1.65000000 ms
T 1.98 V

SIM power-on sequence on X2700.


File
Control
Setup
Measure
Analyze
Utilities
Help
11:54 AM
Acquisition is stopped.
250 kSa/s
1 On 2.00 V/div
2 On 2.00 V/div
3 On 2.00 V/div
4 On 2.00 V/div
VSIM
SIMCLK
IOC
SIMDATA
More (1of 2)
Clear All
H 10.0 ms/div
0.0 s
T 1.98 V

SIM power-on sequence between Rapido and Avilma.

Keyboard troubleshooting

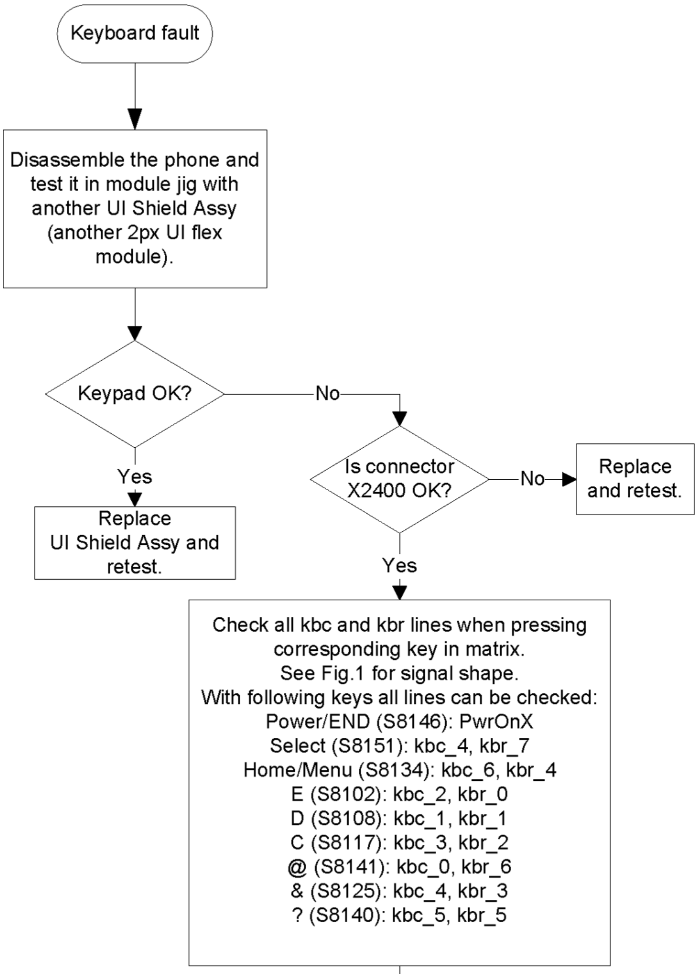
Context

There are two possible failure modes in the keyboard module:

- One or more keys can be stuck, so that the key does not react when a keydome is pressed. This kind of failure is caused by mechanical reasons (dirt, rust).
- Malfunction of several keys at the same time; this happens when one or more rows or columns are failing (shortcut or open connection). For a more detailed description of the keyboard and keymatrix, see section Keyboard.

If the failure mode is not clear, start with the Keyboard Test in Phoenix.

Troubleshooting flow


Keyboard fault
Disassemble the phone and test it in module jig with another UI Shield Assy (another 2px UI flex module).
Keypad OK?
No
Yes
Replace UI Shield Assy and retest.
Is connector X2400 OK?
No
Replace and retest.
Yes
Check all kbc and kbr lines when pressing corresponding key in matrix.
See Fig.1 for signal shape.
With following keys all lines can be checked:
Power/END (S8146): PwrOnX
Select (S8151): kbc_4, kbr_7
Home/Menu (S8134): kbc_6, kbr_4
E (S8102): kbc_2, kbr_0
D (S8108): kbc_1, kbr_1
C (S8117): kbc_3, kbr_2
@ (S8141): kbc_0, kbr_6
& (S8125): kbc_4, kbr_3
? (S8140): kbc_5, kbr_5

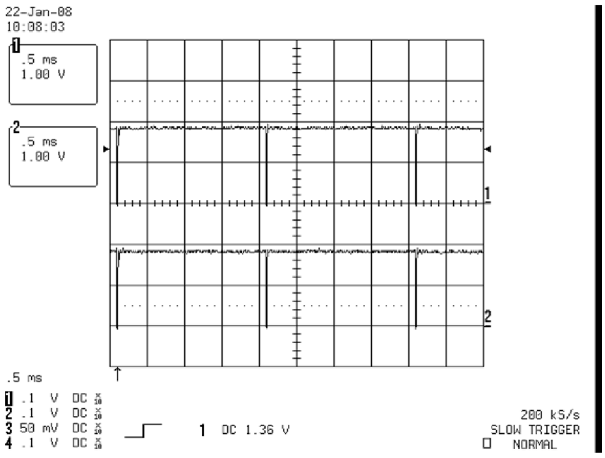
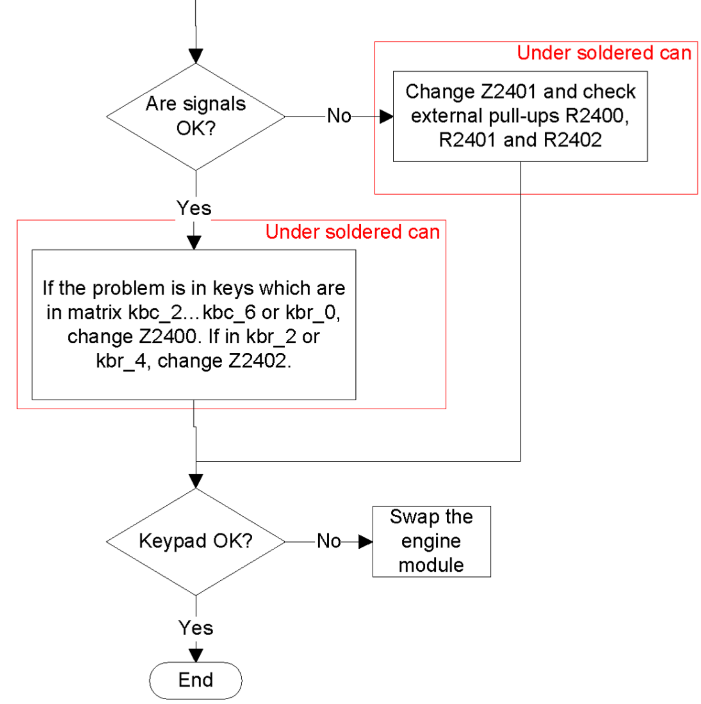
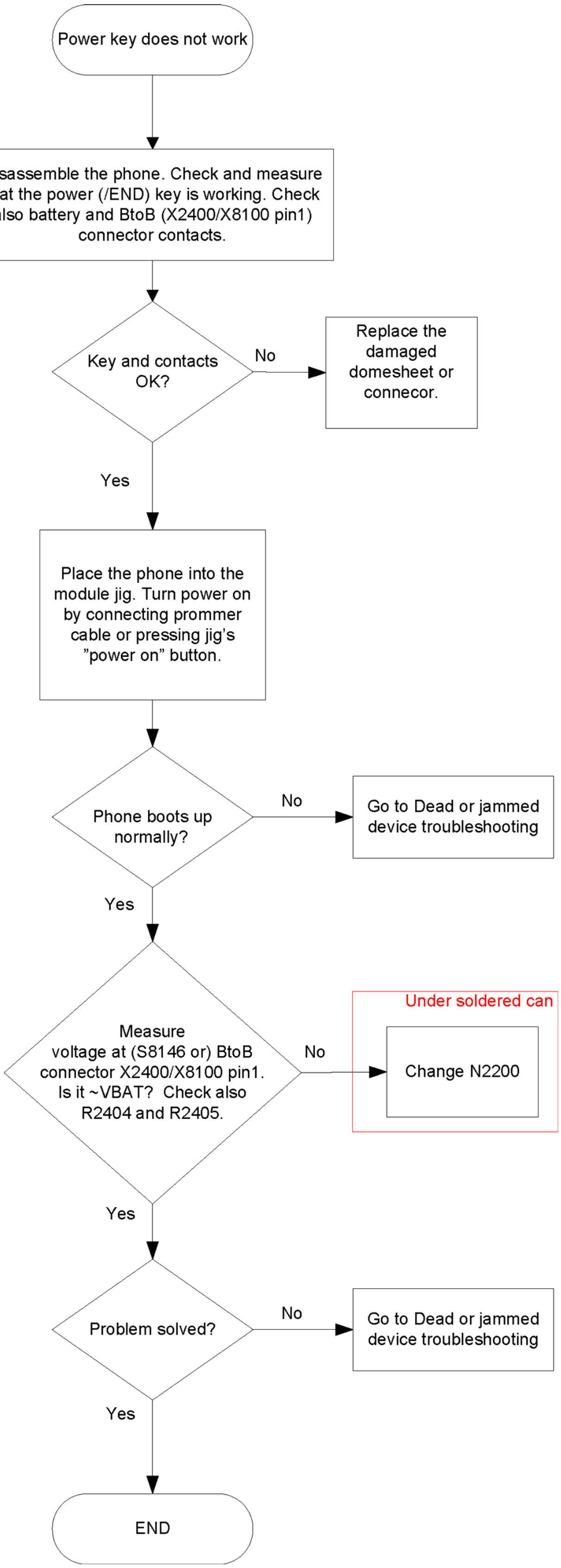


Fig.1: kbc and kbr signals when pressing key


Are signals OK?
No
Under soldered can
Change Z2401 and check external pull-ups R2400, R2401 and R2402
Yes
Under soldered can
If the problem is in keys which are in matrix kbc_2...kbc_6 or kbr_0, change Z2400. If in kbr_2 or kbr_4, change Z2402.
Keypad OK?
No
Swap the engine module
Yes
End

Power key troubleshooting

Troubleshooting flow


Power key does not work
Disassemble the phone. Check and measure that the power (/END) key is working. Check also battery and BtoB (X2400/X8100 pin1) connector contacts.
Key and contacts OK?
No
Replace the damaged domesheet or connecor.
Yes
Place the phone into the module jig. Turn power on by connecting prommer cable or pressing jig's "power on" button.
Phone boots up normally?
No
Go to Dead or jammed device troubleshooting
Yes
Measure voltage at (S8146 or) BtoB connector X2400/X8100 pin1. Is it ~VBAT? Check also R2404 and R2405.
No
Under soldered can
Change N2200
Yes
Problem solved?
No
Go to Dead or jammed device troubleshooting
Yes
END

Display module troubleshooting

General instructions for display troubleshooting

Context

- The display is in a normal mode when the phone is in active use.
- Display is in a partial idle mode when the phone is in the screen saver mode.
- The operating modes of the display can be controlled with the help of *Phoenix*.

Table 10 Display module troubleshooting cases

Display blank	There is no image on the display. The display looks the same when the phone is on as it does when the phone is off. The backlight can be on in some cases.
Image on the display not correct	Image on the display can be corrupted or a part of the image can be missing. If a part of the image is missing, change the display module. If the image is otherwise corrupted, follow the appropriate troubleshooting diagram.
Backlight dim or not working at all	Backlight LED components are inside the display module. Backlight failure can also be in the connector or in the backlight power source in the main engine of the phone. This means that in case the display is working (image OK), the backlight is faulty.
Visual defects (pixel)	Pixel defects can be checked by controlling the display with Phoenix. Use both colours, black and white, on a full screen. The display may have some random pixel defects that are acceptable for this type of display. The criteria when pixel defects are regarded as a display failure, resulting in a replacement of the display, are presented the following table.

Table 11 Pixel defects

Item		White dot defect				Black dot defect	Total
1	Defect counts	R	G	B	White Dot Total	1	1
		1	1	1	1		
2	Combined defect counts	Not allowed. Two single dot defects that are within 5 mm of each other should be interpreted as combined dot defect.					

Steps

1. Verify with a working display that the fault is not on the display module itself.

   The display module cannot be repaired.
2. Check that the cellular engine is working normally.
   - i To check the functionality, connect the phone to a docking station.
   - ii Start *Phoenix* service software.
   - iii Read the phone information to check that also the application engine is functioning normally (you should be able to read the APE ID).
3. Proceed to the display troubleshooting flowcharts.

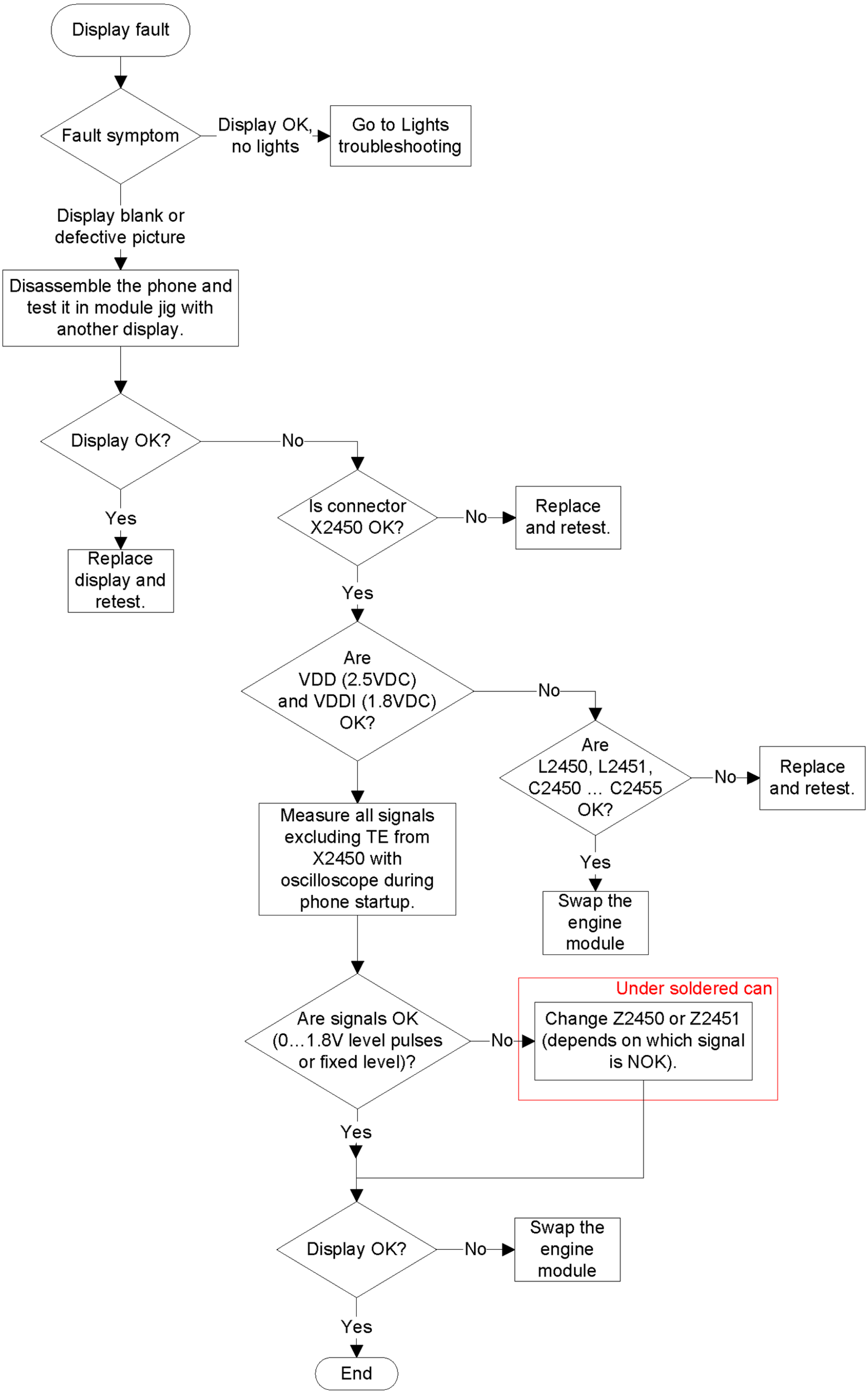
   Use the **Display Test** tool in *Phoenix* to find the detailed fault mode.

Display troubleshooting

Context

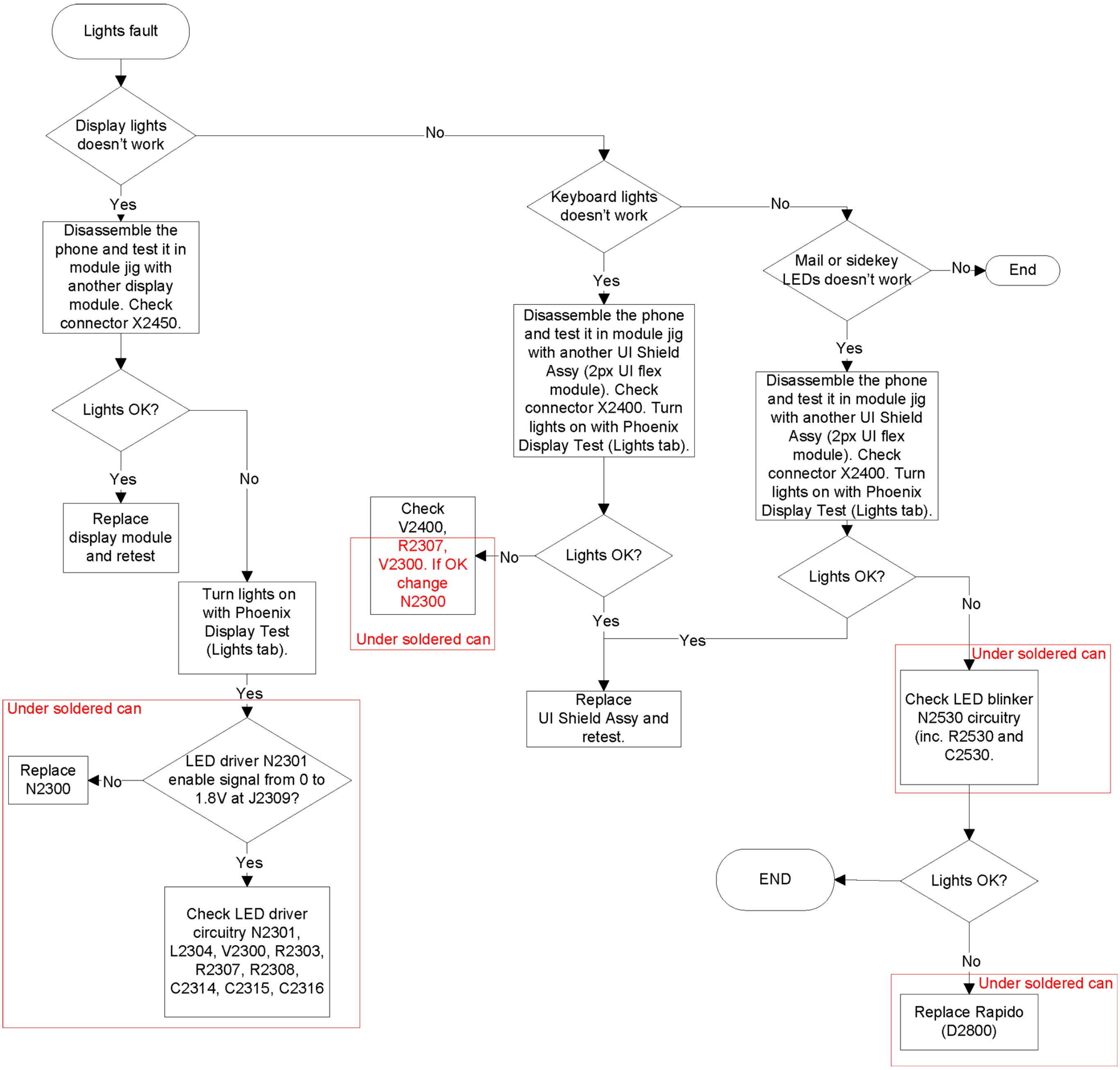
Before going to display troubleshooting flow, make sure that the engine is working and starting up correctly. If the problem is in the engine, go to baseband troubleshooting.

Troubleshooting flow


Display fault
Fault symptom
Display OK, no lights
Go to Lights troubleshooting
Display blank or defective picture
Disassemble the phone and test it in module jig with another display.
Display OK?
No
Yes
Replace display and retest.
Is connector X2450 OK?
No
Replace and retest.
Yes
Are VDD (2.5VDC) and VDDI (1.8VDC) OK?
No
Are L2450, L2451, C2450 … C2455 OK?
No
Replace and retest.
Yes
Swap the engine module
Measure all signals excluding TE from X2450 with oscilloscope during phone startup.
Are signals OK (0…1.8V level pulses or fixed level)?
No
Under soldered can
Change Z2450 or Z2451 (depends on which signal is NOK).
Yes
Display OK?
No
Swap the engine module
Yes
End

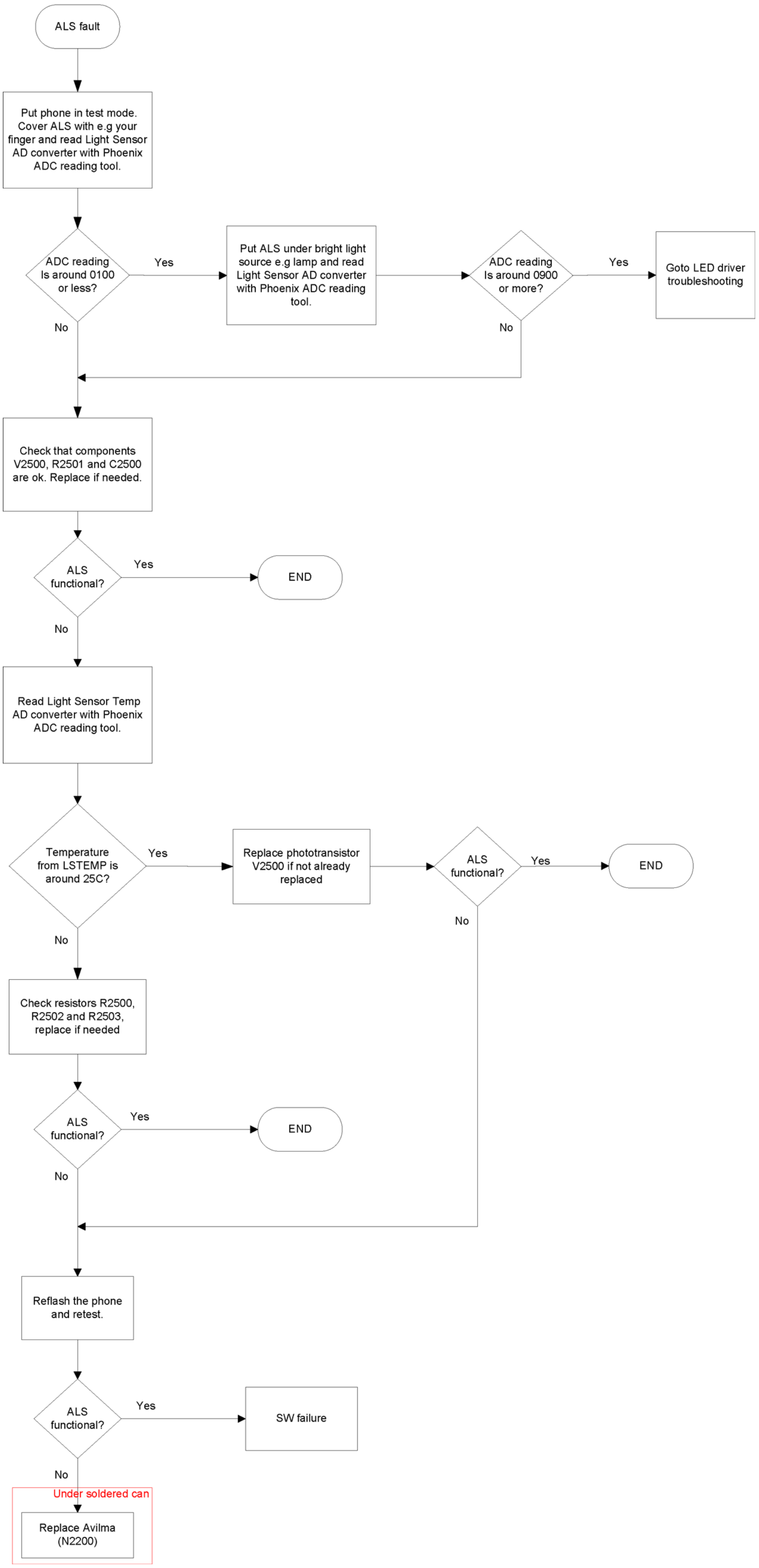
Lights (display/keyboard) troubleshooting

Troubleshooting flow


Lights fault
Display lights doesn't work
No
Yes
Disassemble the phone and test it in module jig with another display module. Check connector X2450.
Lights OK?
Yes
No
Replace display module and retest
Turn lights on with Phoenix Display Test (Lights tab).
Yes
Under soldered can
Replace N2300
No
LED driver N2301 enable signal from 0 to 1.8V at J2309?
Yes
Check LED driver circuitry N2301, L2304, V2300, R2303, R2307, R2308, C2314, C2315, C2316
Keyboard lights doesn't work
No
Yes
Disassemble the phone and test it in module jig with another UI Shield Assy (2px UI flex module). Check connector X2400. Turn lights on with Phoenix Display Test (Lights tab).
Check V2400, R2307, V2300. If OK change N2300
Under soldered can
No
Lights OK?
Yes
Yes
Replace UI Shield Assy and retest.
Mail or sidekey LEDs doesn't work
No
End
Yes
Disassemble the phone and test it in module jig with another UI Shield Assy (2px UI flex module). Check connector X2400. Turn lights on with Phoenix Display Test (Lights tab).
Lights OK?
No
Under soldered can
Check LED blinker N2530 circuitry (inc. R2530 and C2530.
END
Lights OK?
No
Under soldered can
Replace Rapido (D2800)

ALS troubleshooting

Troubleshooting flow


ALS fault
Put phone in test mode. Cover ALS with e.g your finger and read Light Sensor AD converter with Phoenix ADC reading tool.
ADC reading Is around 0100 or less?
Yes
No
Put ALS under bright light source e.g lamp and read Light Sensor AD converter with Phoenix ADC reading tool.
ADC reading Is around 0900 or more?
Yes
No
Goto LED driver troubleshooting
Check that components V2500, R2501 and C2500 are ok. Replace if needed.
ALS functional?
Yes
END
No
Read Light Sensor Temp AD converter with Phoenix ADC reading tool.
Temperature from LSTEMP is around 25C?
Yes
Replace phototransistor V2500 if not already replaced
ALS functional?
Yes
END
No
No
Check resistors R2500, R2502 and R2503, replace if needed
ALS functional?
Yes
END
No
Reflash the phone and retest.
ALS functional?
Yes
SW failure
No
Under soldered can
Replace Avilma (N2200)

Bluetooth troubleshooting

Introduction to Bluetooth troubleshooting

There are two main Bluetooth problems that can occur:

Problem	Description
Detachment of the BT antenna.	This would most likely happen if the device has been dropped repeatedly to the ground. It could cause the BT antenna to become loose or partially detached from the PWB.
A malfunction in the BT ASIC, BB ASICs or Phone's BT SMD components.	This is unpredictable and could have many causes i.e. SW or HW related.

The main issue is to find out if the problem is related to the BT antenna or related to the BT system or the phone's BB and then replace/fix the faulty component.

Bluetooth antenna

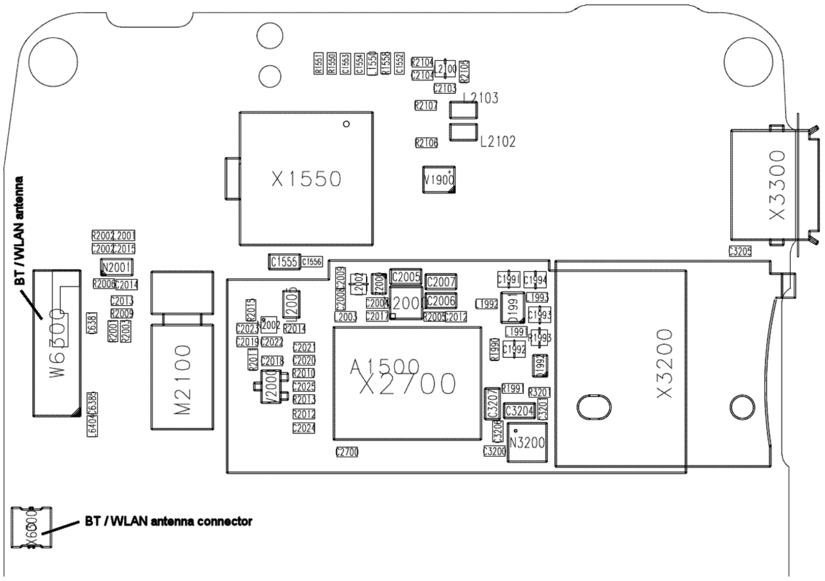


Figure 7 RM-437 Bluetooth antenna

Bluetooth settings for Phoenix

Steps

1. Start *Phoenix* service software.
2. Place the phone to a flash adapter in the local mode.
3. From the **File** menu, choose **Open Product**, and then choose the correct type designator from the **Product** list.
4. Choose **Testing→Bluetooth LOCALS** .
5. Locate SB-6's serial number (12 digits) found in the type label on the back of SB-6.

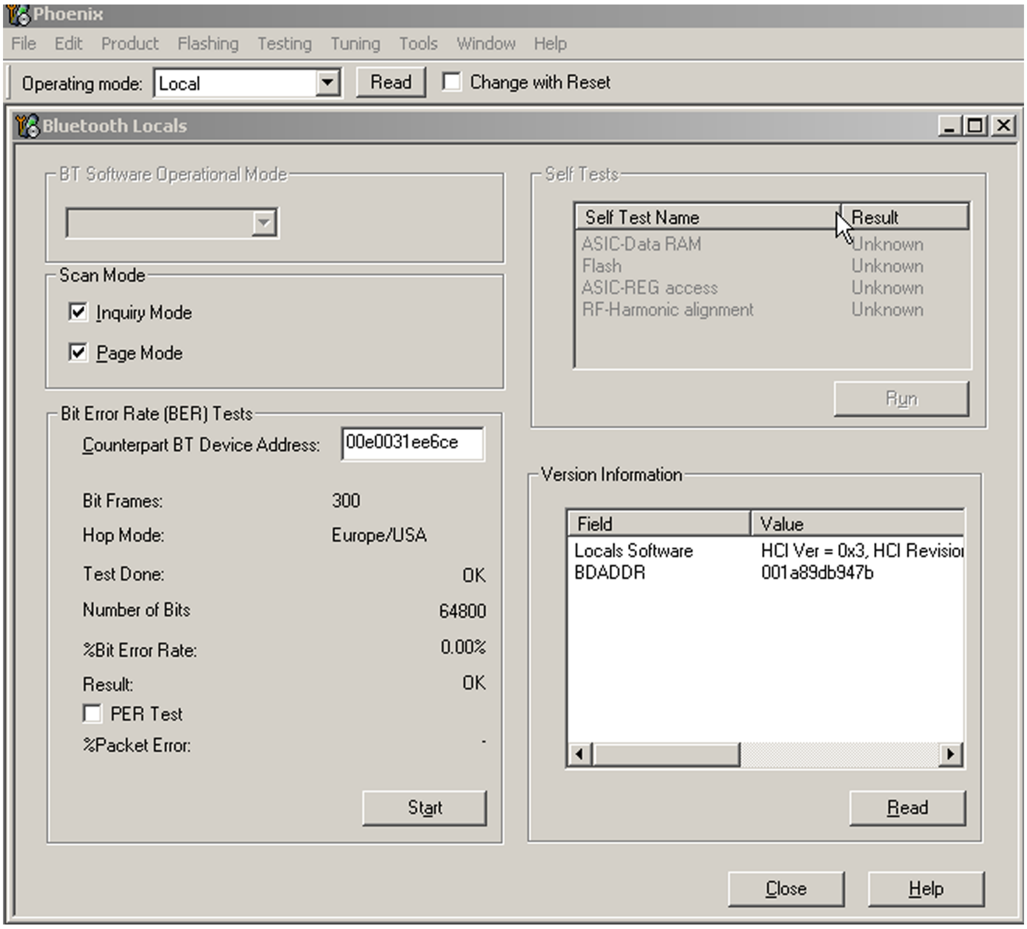
   In addition to SB-6 , also JBT-3, JBT-6 and JBT-9 Bluetooth test boxes can be used.
6. In the *Bluetooth LOCALS* window, write the 12-digit serial number on the **Counterpart BT Device Address** line.

This needs to be done only once provided that SB-6 is not changed.

7. Place the SB-6 box near (within 10 cm) the BT antenna and click **Run BER Test**.

Results

Bit Error Rate test result is displayed in the *Bit Error Rate (BER) Tests* pane in the *Bluetooth LOCALS* window.


Phoenix
File Edit Product Flashing Testing Tuning Tools Window Help
Read
Bluetooth Locals
BT Software Operational Mode
Scan Mode
Self Tests
Run
Bit Error Rate (BER) Tests
Version Information
Start
Read
Close
Help

Operating mode: Local

☐ Change with Reset

☑ Inquiry Mode

☑ Page Mode

Counterpart BT Device Address: 00e0031ee6ce

Bit Frames: 300

Hop Mode: Europe/USA

Test Done: OK

Number of Bits 64800

%Bit Error Rate: 0.00%

Result: OK

☐ PER Test

%Packet Error: -

Self Test Name	Result
ASIC-Data RAM	Unknown
Flash	Unknown
ASIC-REG access	Unknown
RF-Harmonic alignment	Unknown

Field	Value
Locals Software	HCI Ver = 0x3, HCI Revisio
BDADDR	001a89db947b

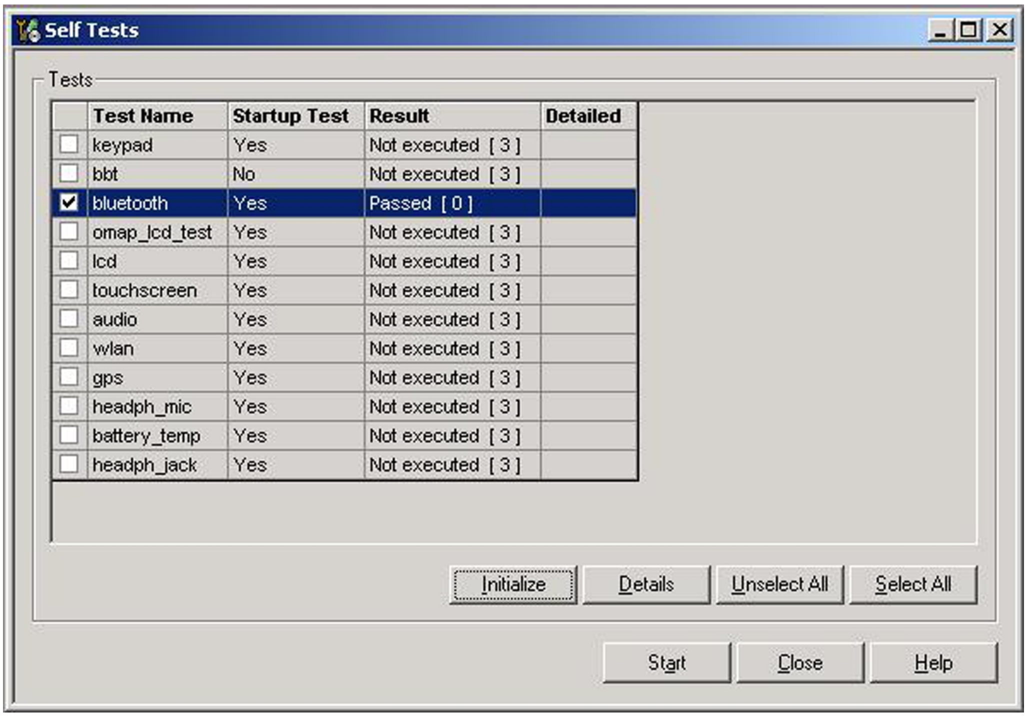
Figure 8 BER test result

Bluetooth self tests in Phoenix

Steps

1. Start *Phoenix* service software.
2. Choose**File→Scan Product.**
3. Place the phone to a flash adapter.
4. From the **Mode** drop-down menu, set mode to **Local**.
5. Choose **Testing→Self Tests.**
6. In the *Self Tests* window check the following Bluetooth related tests:
    - **ST_LPRF_IF_TEST**
    - **ST_LPRF_AUDIO_LINES_TEST**
    - **ST_BT_WAKEUP_TEST**

7. To run the tests, click **Start**.


Self Tests
Tests
Initialize
Details
Unselect All
Select All
Start
Close
Help

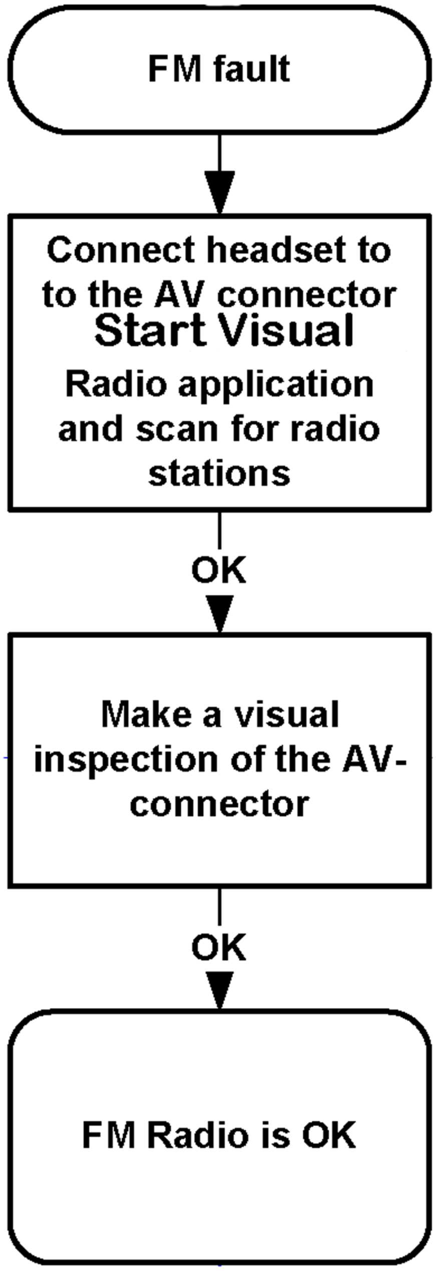
	Test Name	Startup Test	Result	Detailed
☐	keypad	Yes	Not executed [3]	
☐	bbt	No	Not executed [3]	
☑	bluetooth	Yes	Passed [0]	
☐	omap_lcd_test	Yes	Not executed [3]	
☐	lcd	Yes	Not executed [3]	
☐	touchscreen	Yes	Not executed [3]	
☐	audio	Yes	Not executed [3]	
☐	wlan	Yes	Not executed [3]	
☐	gps	Yes	Not executed [3]	
☐	headph_mic	Yes	Not executed [3]	
☐	battery_temp	Yes	Not executed [3]	
☐	headph_jack	Yes	Not executed [3]	

Figure 9 Bluetooth self tests in *Phoenix*

■ FM radio troubleshooting

FM radio troubleshooting

Troubleshooting flow


FM fault
Connect headset to to the AV connector Start Visual Radio application and scan for radio stations
OK
Make a visual inspection of the AV-connector
OK
FM Radio is OK

■ WLAN troubleshooting

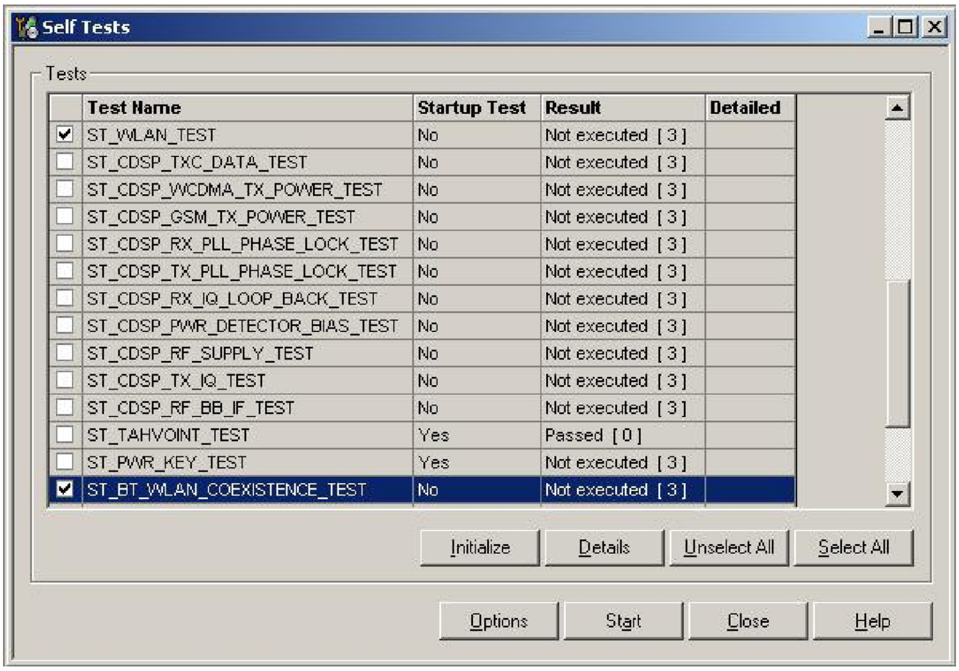
Introduction to WLAN troubleshooting

The main problem that can occur is malfunction in WLAN ASICs, WLAN SMD or Antenna components. Such problems are unpredictable and may have many causes, either HW or SW related.

WLAN functionality testing with self tests

Steps

1. Start Phoenix service software.
2. **Choose File => Scan Product**.
3. From the **Mode** drop-down menu, set mode to **Local**.
4. **Choose Testing => Self Tests**.
5. In the Self Tests window select the following WLAN related tests:
    - **ST_WLAN_TEST**
    - **ST_BT_WLAN_COEXISTENCE_TEST**
6. Press **Start** and after few seconds results should appear and if WLAN engine is functional, results should show **Passed**. If one of the tests is **Failed** then there is something broken inside the WLAN module.

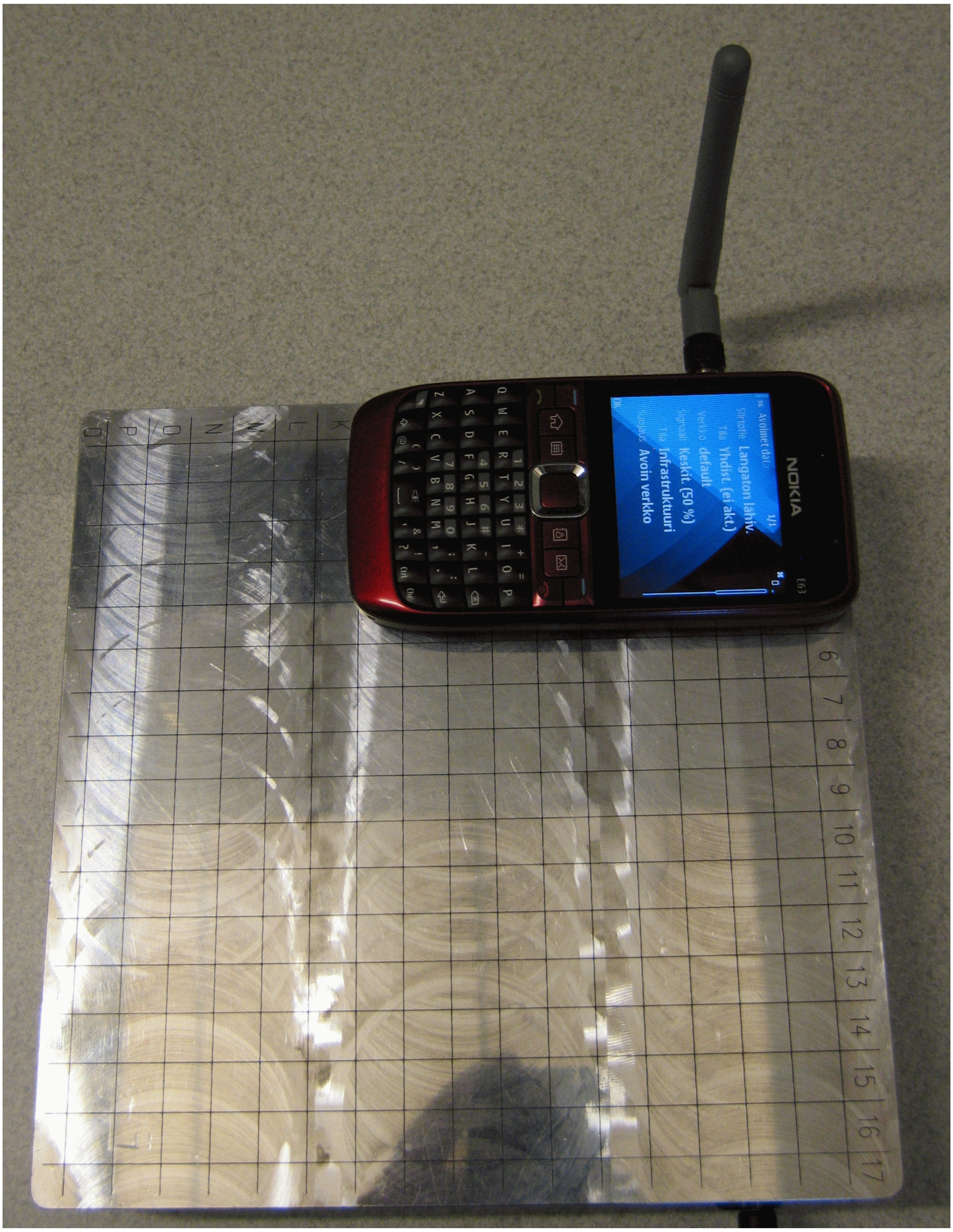


	Test Name	Startup Test	Result	Detailed
☑	ST_WLAN_TEST	No	Not executed [3]	
☐	ST_CDSP_TXC_DATA_TEST	No	Not executed [3]	
☐	ST_CDSP_WCDMA_TX_POWER_TEST	No	Not executed [3]	
☐	ST_CDSP_GSM_TX_POWER_TEST	No	Not executed [3]	
☐	ST_CDSP_RX_PLL_PHASE_LOCK_TEST	No	Not executed [3]	
☐	ST_CDSP_TX_PLL_PHASE_LOCK_TEST	No	Not executed [3]	
☐	ST_CDSP_RX_IQ_LOOP_BACK_TEST	No	Not executed [3]	
☐	ST_CDSP_PWR_DETECTOR_BIAS_TEST	No	Not executed [3]	
☐	ST_CDSP_RF_SUPPLY_TEST	No	Not executed [3]	
☐	ST_CDSP_TX_IQ_TEST	No	Not executed [3]	
☐	ST_CDSP_RF_BB_IF_TEST	No	Not executed [3]	
☐	ST_TAHVOINT_TEST	Yes	Passed [0]	
☐	ST_PWR_KEY_TEST	Yes	Not executed [3]	
☑	ST_BT_WLAN_COEXISTENCE_TEST	No	Not executed [3]	

WLAN functionality testing using SB-7

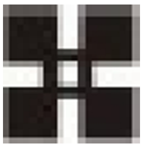
Steps

1. Place the phone on the SB-7 WLAN test box, (see figure).

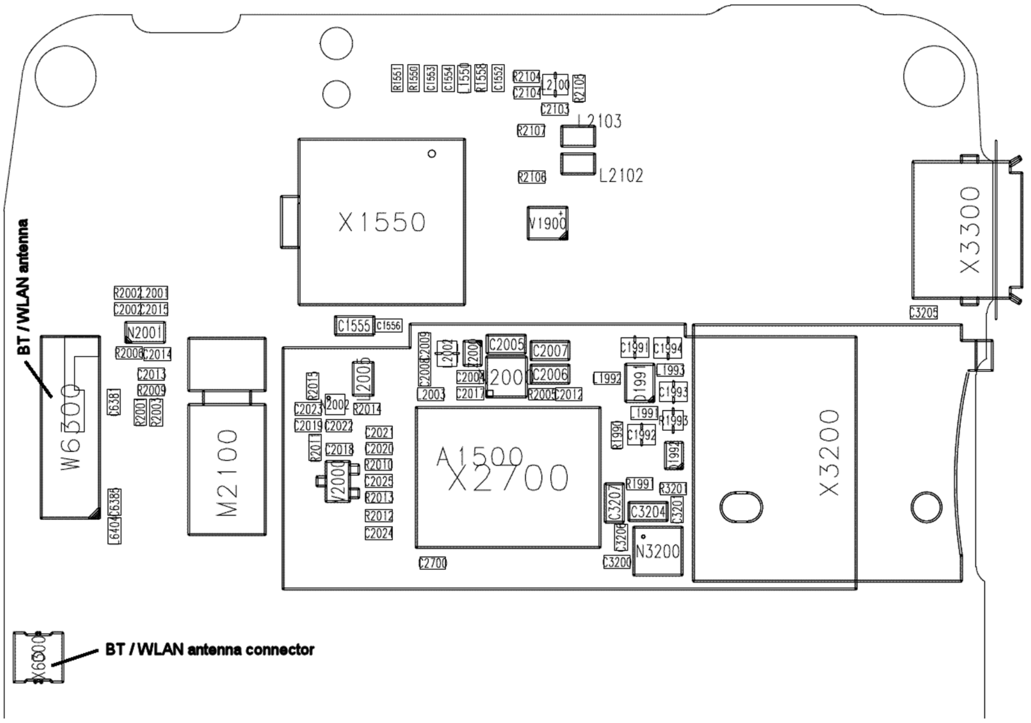


2. Start the phone to the normal mode.

3. Specify AP for the WLAN AP inside the SB-7: go to the **Application – Tools – Settings – Connection – Access points** -menu. Select **Options** and then select **New access point** and then set the following information:
    - a Connection name: **default**
    - b Data bearer: **Wireless LAN**
    - c WLAN network name: **default**
    - d Network status: **Public**
    - e WLAN network mode: **Infrastructure**
    - f WLAN security mode: **Open network**
    - g WLAN security settings: leave it as it is
    - h Homepage: **192.168.0.51**
4. Go back to the top level by pressing **Back – Back – Exit – Back – Exit**.
5. Go to the **Application** –menu and select **Web**.
6. Open the **Options** –menu and select **Settings** and **General**.
    - a Define **Access point – User defined** and select **Default** from the pop-up menu.
    - b Define **Homepage – User defined** and enter **192.168.0.51.**
7. Go back to the top level by pressing **Back – Back – Exit – Exit**.
8. Go to the **Application** –menu and select **Web**. Ignore the error message: **Web**, no gateway reply - this is due to the fact that SB-7 is not connected to the internet.
9. Press **Application** button until you can select **Standby**.
10. Go to the **Application** –menu and select **Connectivity – Conn.mgr**. and select **Active data connections**. Now you should see the connection named **default** and below the name there should be time running. Or if you came very fast to this menu after turning browser on, there may be indication of **connecting** below the name **default**. If so, wait until time starts to run below the name **default**. Select these connections from the **Options** –menu by selecting **Details**.
    - a Status should show: **Conn. (inactive... or Conn. (active)**.
    - b Signal should show: **Medium (50%)**. This field can also be **Strong** and percent number can also be higher.
11. WiFi indicator top of the screen should be ON when connected to the AP



12. If connection does not work, check the phone's **WLAN / BT** –antenna and matching components. See figure below.


BT / WLAN antenna
BT / WLAN antenna connector
X1550
L2103
L2102
V1900
X3300
W6300
N2001
M2100
A1500
X2700
X3200
N3200
X6300

Acoustics troubleshooting

Introduction to acoustics troubleshooting

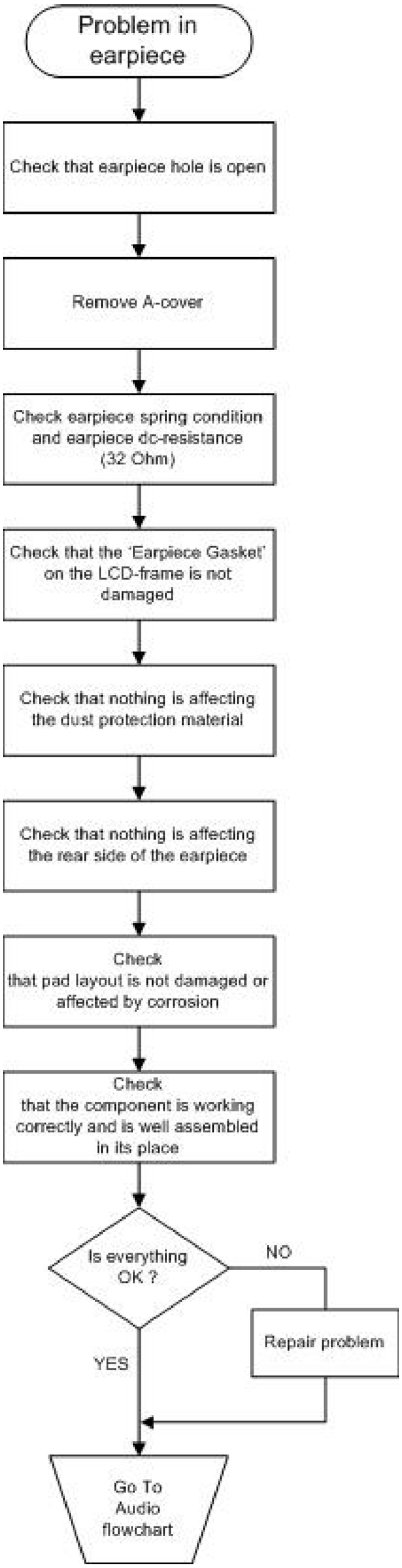
Acoustics design ensures that the sound is detected correctly with a microphone and properly radiated to the outside of the device by speaker(s). The acoustics of the phone includes three basic systems: earpiece, Integrated Hands Free (IHF) and microphone.

The sound reproduced from the earpiece readiates through a single hole on the front cover (A-cover). The sound reproduced from the IHF speakers radiates from left and right sound holes located on both sides of the device. Microphone is located at the bottom, next to the system connector.

For a correct functionality of the phone, all sound holes must be always open. When the phone is used, care must be taken not to close any of those holes with a hand or fingers. The phone should be dry and clean, and no objects must be located in such a way that they close any of the holes.

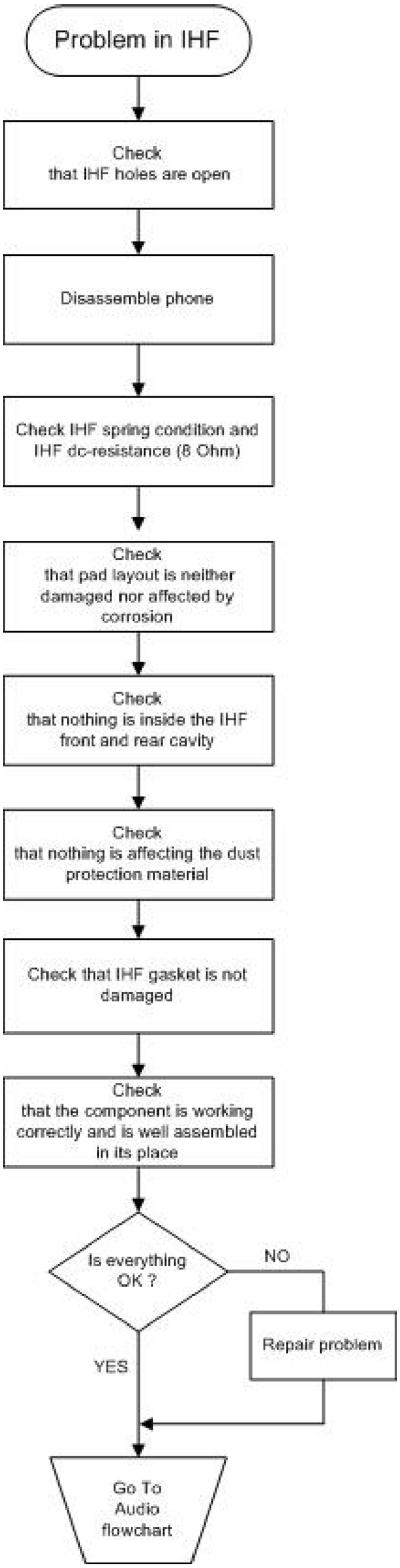
Earpiece troubleshooting

Troubleshooting flow


Problem in earpiece
Check that earpiece hole is open
Remove A-cover
Check earpiece spring condition and earpiece dc-resistance (32 Ohm)
Check that the 'Earpiece Gasket' on the LCD-frame is not damaged
Check that nothing is affecting the dust protection material
Check that nothing is affecting the rear side of the earpiece
Check that pad layout is not damaged or affected by corrosion
Check that the component is working correctly and is well assembled in its place
Is everything OK ?
NO
Repair problem
YES
Go To Audio flowchart

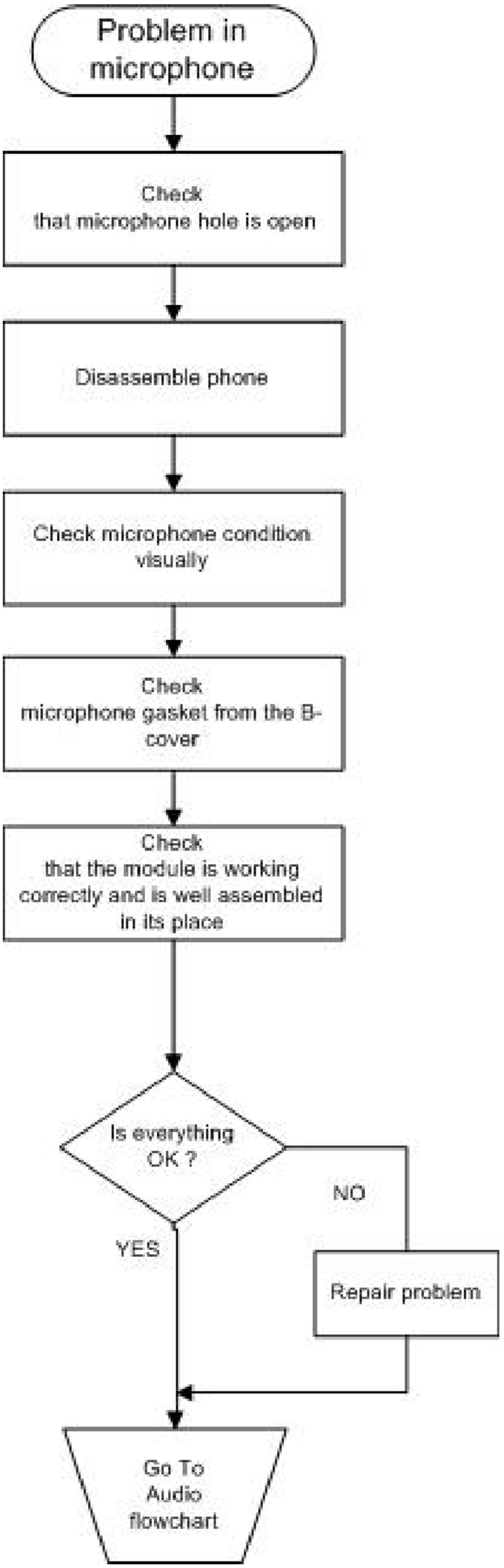
IHF troubleshooting

Troubleshooting flow


Problem in IHF
Check that IHF holes are open
Disassemble phone
Check IHF spring condition and IHF dc-resistance (8 Ohm)
Check that pad layout is neither damaged nor affected by corrosion
Check that nothing is inside the IHF front and rear cavity
Check that nothing is affecting the dust protection material
Check that IHF gasket is not damaged
Check that the component is working correctly and is well assembled in its place
Is everything OK ?
NO
Repair problem
YES
Go To Audio flowchart

Microphone troubleshooting

Troubleshooting flow


Problem in microphone
Check that microphone hole is open
Disassemble phone
Check microphone condition visually
Check microphone gasket from the B-cover
Check that the module is working correctly and is well assembled in its place
Is everything OK ?
NO
YES
Repair problem
Go To Audio flowchart

Audio troubleshooting

Audio troubleshooting test instructions

Single-ended external earpiece and differential internal earpiece outputs can be measured either with a single-ended or a differential probe.

When measuring with a single-ended probe each output is measured against the ground.

Internal handsfree output is measured using a current probe, if a special low-pass filter designed for measuring a digital amplifier is not available. Note also that when using a current probe, the input signal frequency must be set to 2kHz.

The input signal for each loop test can be either single-ended or differential. Exception to this is a digital microphone, which needs input signal from an external sound source (laptop speaker) to playback eg. 1kHz sine wave from 5cm distance.

Required equipment

The following equipment is needed for the tests:

- Oscilloscope
- Function generator (sine waveform)
- Current probe (Internal handsfree PWM output measurement)
- Phoenix service software
- Battery voltage 3.7V
- Sound source (laptop speaker or B&K type 4231 calibrator)

Test procedure

Audio can be tested using the Phoenix audio routings option. Three different audio loop paths can be activated:

- External microphone to Internal earpiece
- External microphone to Internal handsfree speaker
- Digital stereo microphone to External earpiece

Each audio loop sets routing from the specified input to the specified output enabling a quick in-out test. Loop path gains are fixed and they cannot be changed using Phoenix. Correct pins and signals for each test are presented in the following table.

Phoenix audio loop tests and test results

The results presented in the table apply when no accessory is connected and battery voltage is set to 3.7V.

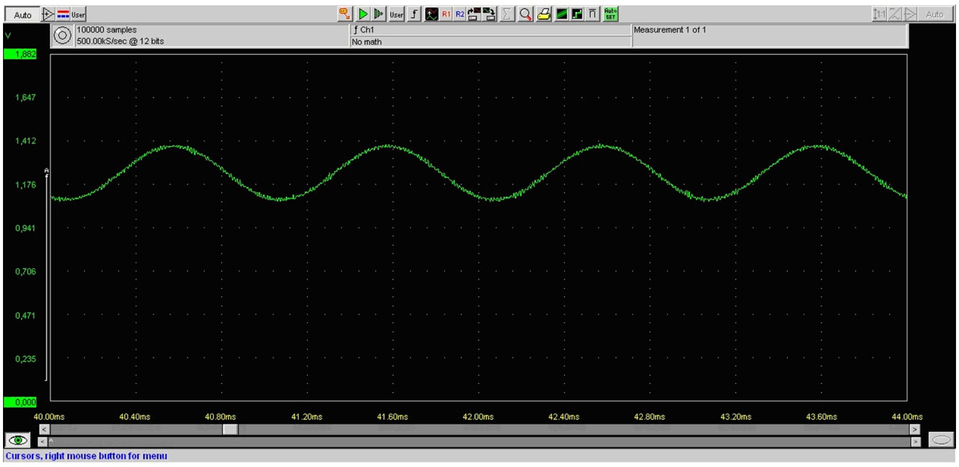
Earpiece, internal microphone and speaker are in place during measurement. Applying a headset accessory during measurement causes a significant drop in measured quantities.

The gain values presented in the table apply for a differential output vs. single-ended/differential input.

Loop test	Input terminal	Output terminal	Path gain [dB] (fixed)	Input voltage [mVp-p]	Output voltage [mVp-p]	Output DC level [V]	Output current [mA]
External Mic to External Earpiece	HS_MIC & GND	HS_EAR_L & GND	-8.6	1000	367	1.2	NA
		HS_EAR_R & GND					
External Mic to Internal Earpiece	HS_MIC & GND	EarP & GND	-10	1000	310	1.2	NA
		EarN & GND					
External Mic to Internal handsfree	HS_MIC & GND	J2103 & J2104	-6	1000			
		J2101 & J2102					
Digital Mic to External Earpiece	Acoustical input, 1kHz sine wave	HS_EAR_L & GND	NA	94 dB SPL	100		NA
		HS_EAR_R & GND					

Measurement data

Earpiece signal



100000 samples
500.00kS/sec @ 12 bits
ƒ Ch1
No math
Measurement 1 of 1

Auto
User
Auto
V
1,882
1,647
1,412
1,176
0,941
0,706
0,471
0,235
0,000
40.00ms
40.40ms
40.80ms
41.20ms
41.60ms
42.00ms
42.40ms
42.80ms
43.20ms
43.60ms
44.00ms
Cursors, right mouse button for menu

Figure 10 Single-ended output waveform of the Ext_in_HP_out measurement when earpiece is connected.

Integrated handsfree signal

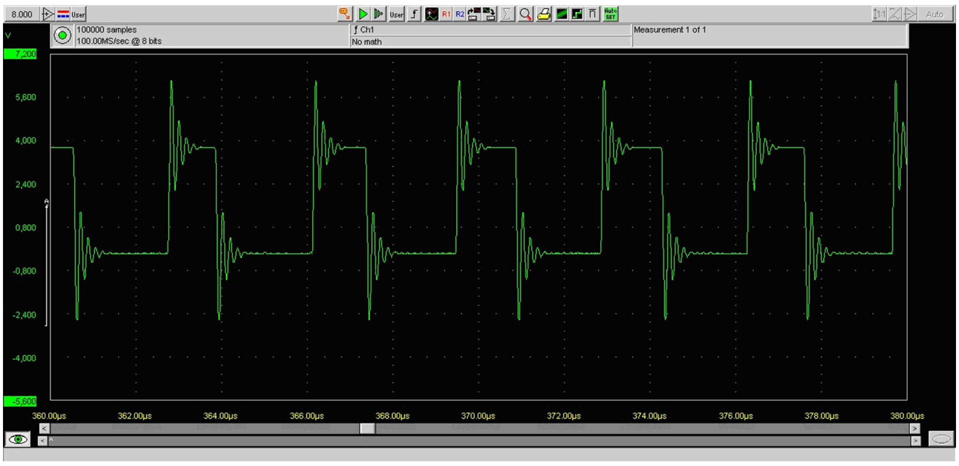

8,000
User
100000 samples
100.00MS/sec @ 8 bits
Ch1
No math
Measurement 1 of 1
Auto
V
7,200
5,600
4,000
2,400
0,800
-0,800
-2,400
-4,000
-5,600
360.00µs
362.00µs
364.00µs
366.00µs
368.00µs
370.00µs
372.00µs
374.00µs
376.00µs
378.00µs
380.00µs

Figure 11 Single-ended output waveform of the Ext_in_IHF_out loop measurement when speaker is connected (measured at speaker pads). No filter is used.

External output from AV

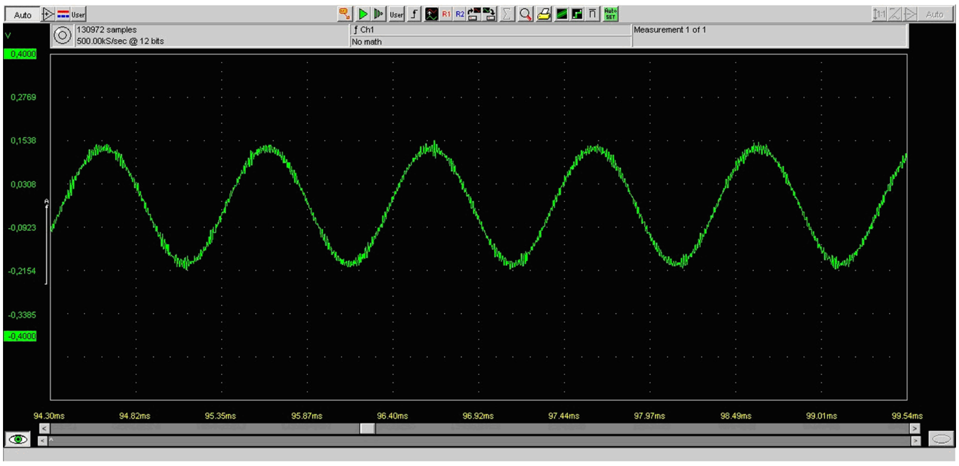

Auto
User
130972 samples
500.00kS/sec @ 12 bits
Ch1
No math
Measurement 1 of 1
Auto
V
0,4000
0,2769
0,1538
0,0308
-0,0923
-0,2154
-0,3385
-0,4000
94.30ms
94.82ms
95.35ms
95.87ms
96.40ms
96.92ms
97.44ms
97.97ms
98.49ms
99.01ms
99.54ms

Figure 12 Single-ended output waveform of the Ext_in_Ext_out loop.

External output from AV (acoustic input)

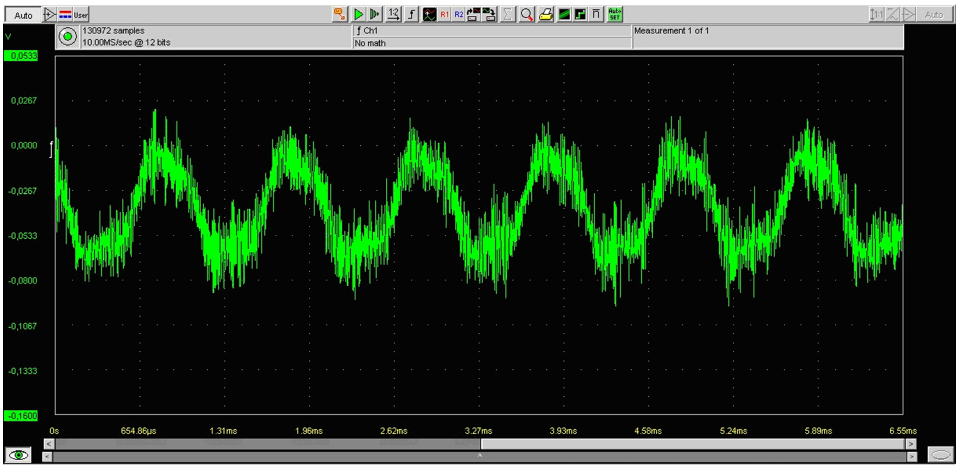
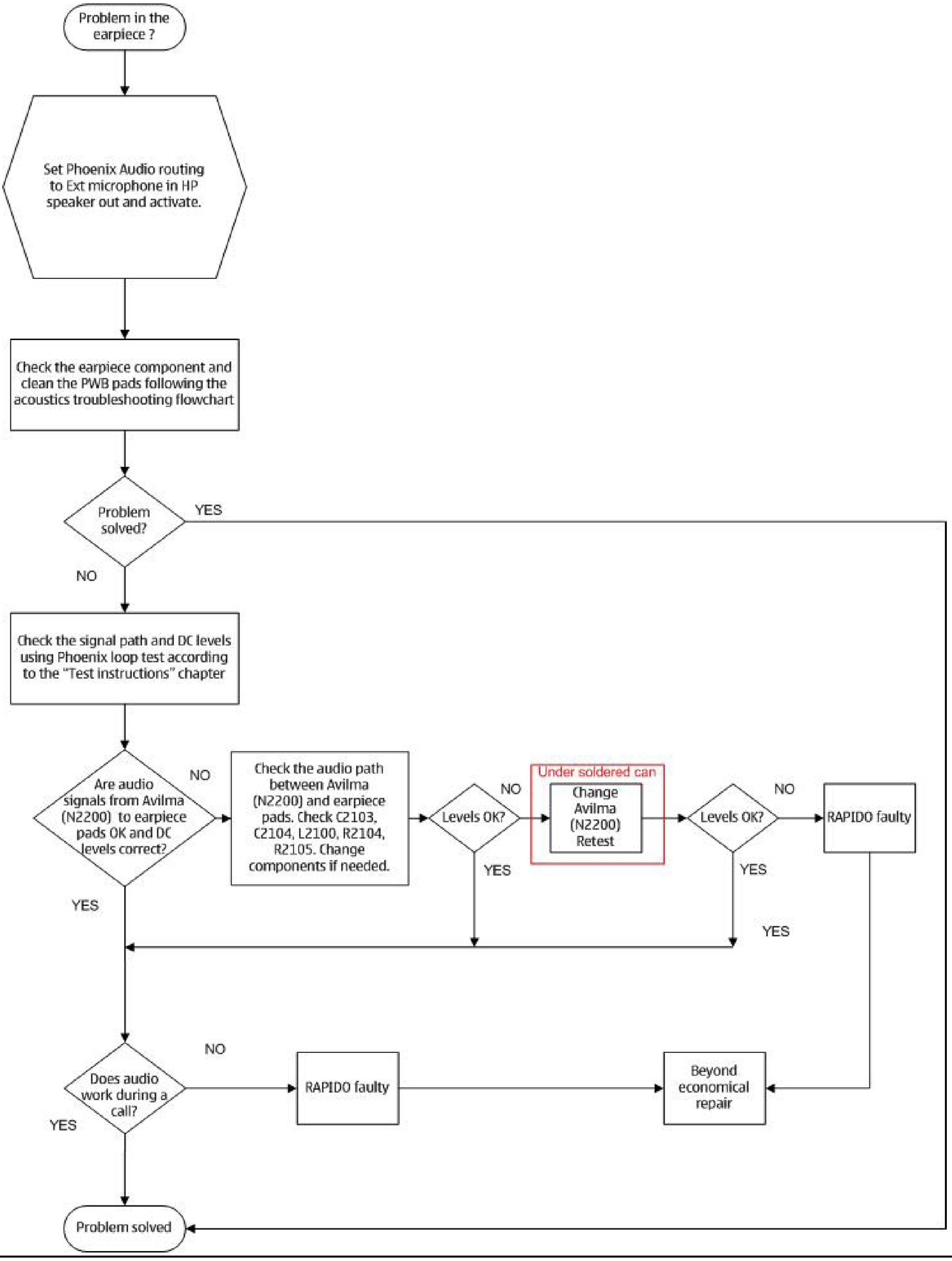

Auto
User
130972 samples
10.00MS/sec @ 12 bits
Ch1
No math
Measurement 1 of 1
Auto
V
0,0533
0,0267
0,0000
-0,0267
-0,0533
-0,0800
-0,1067
-0,1333
-0,1600
0s
654.86µs
1.31ms
1.96ms
2.62ms
3.27ms
3.93ms
4.58ms
5.24ms
5.89ms
6.55ms

Figure 13 Single-ended output waveform of the Digital_stereo_microphone_in_Ext_out loop.

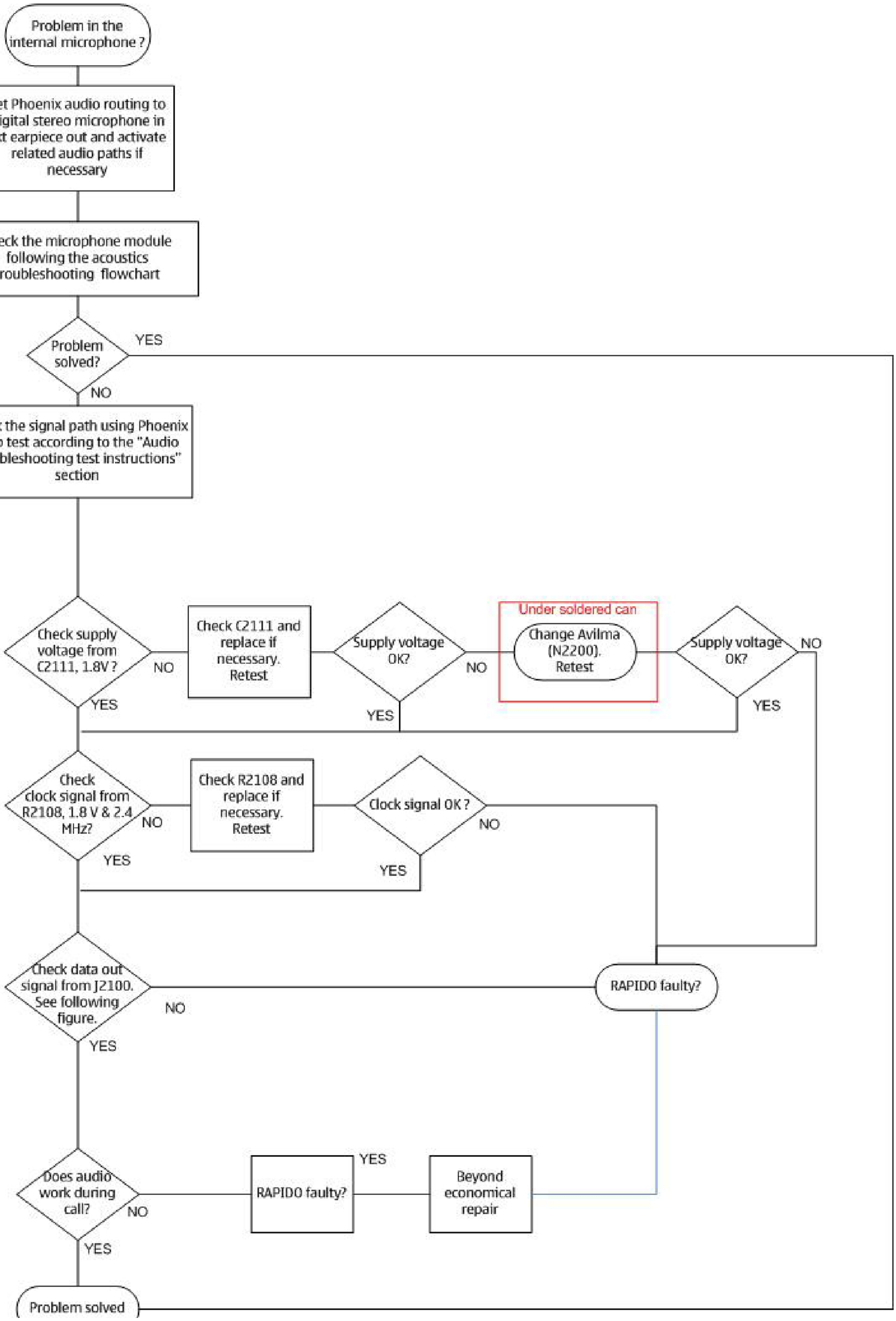
Internal earpiece troubleshooting

Troubleshooting flow


Problem in the earpiece ?
Set Phoenix Audio routing to Ext microphone in HP speaker out and activate.
Check the earpiece component and clean the PWB pads following the acoustics troubleshooting flowchart
Problem solved?
YES
NO
Check the signal path and DC levels using Phoenix loop test according to the "Test instructions" chapter
Are audio signals from Avilma (N2200) to earpiece pads OK and DC levels correct?
NO
Check the audio path between Avilma (N2200) and earpiece pads. Check C2103, C2104, L2100, R2104, R2105. Change components if needed.
Levels OK?
NO
YES
Under soldered can
Change Avilma (N2200) Retest
Levels OK?
NO
YES
RAPIDO faulty
YES
YES
NO
Does audio work during a call?
YES
RAPIDO faulty
Beyond economical repair
Problem solved

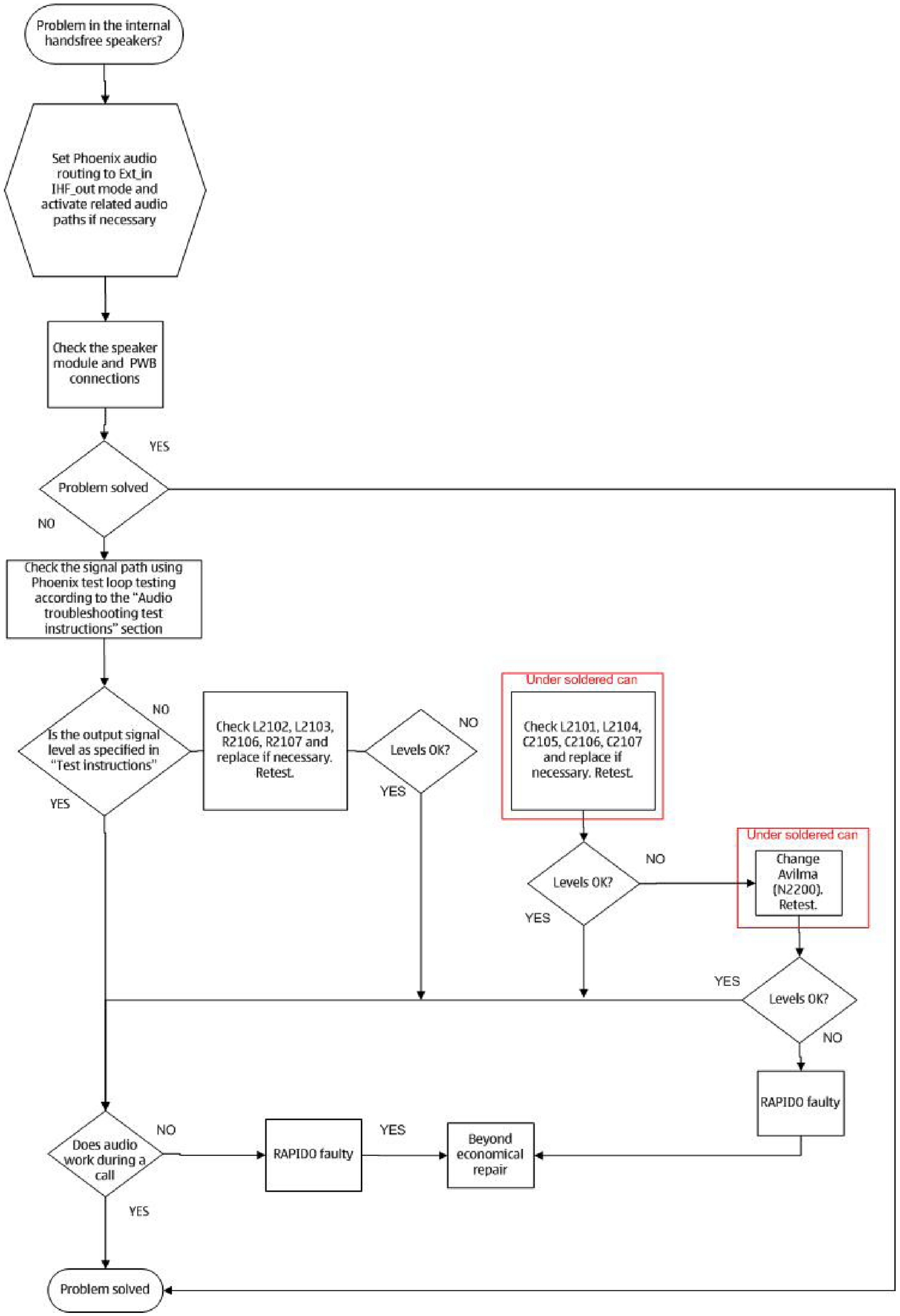
Internal microphone troubleshooting

Troubleshooting flow


Problem in the internal microphone ?
Set Phoenix audio routing to Digital stereo microphone in Ext earpiece out and activate related audio paths if necessary
Check the microphone module following the acoustics troubleshooting flowchart
Problem solved?
YES
NO
Check the signal path using Phoenix loop test according to the "Audio troubleshooting test instructions" section
Check supply voltage from C2111, 1.8V ?
NO
YES
Check C2111 and replace if necessary. Retest
Supply voltage OK?
NO
YES
Under soldered can
Change Avilma (N2200). Retest
Supply voltage OK?
NO
YES
Check clock signal from R2108, 1.8 V & 2.4 MHz?
NO
YES
Check R2108 and replace if necessary. Retest
Clock signal OK ?
NO
YES
Check data out signal from J2100. See following figure.
NO
YES
RAPIDO faulty?
Does audio work during call?
NO
YES
RAPIDO faulty?
YES
Beyond economical repair
Problem solved

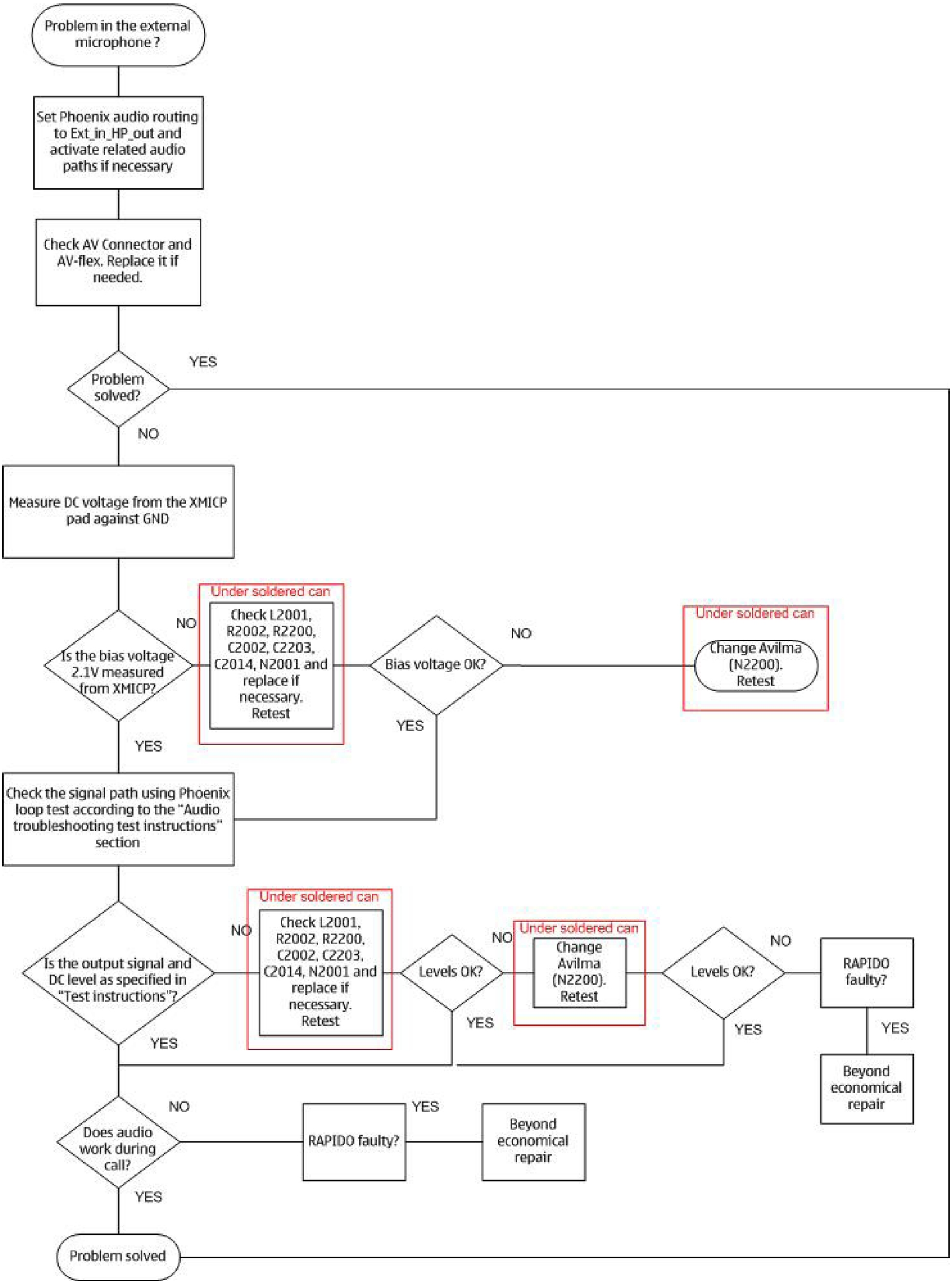
IHF speakers troubleshooting

Troubleshooting flow


Problem in the internal handsfree speakers?
Set Phoenix audio routing to Ext_in IHF_out mode and activate related audio paths if necessary
Check the speaker module and PWB connections
YES
Problem solved
NO
Check the signal path using Phoenix test loop testing according to the "Audio troubleshooting test instructions" section
NO
Is the output signal level as specified in "Test instructions"
YES
Check L2102, L2103, R2106, R2107 and replace if necessary. Retest.
NO
Levels OK?
YES
Under soldered can
Check L2101, L2104, C2105, C2106, C2107 and replace if necessary. Retest.
NO
Levels OK?
YES
Under soldered can
Change Avilma (N2200). Retest.
YES
Levels OK?
NO
RAPIDO faulty
NO
Does audio work during a call
RAPIDO faulty
YES
Beyond economical repair
YES
Problem solved

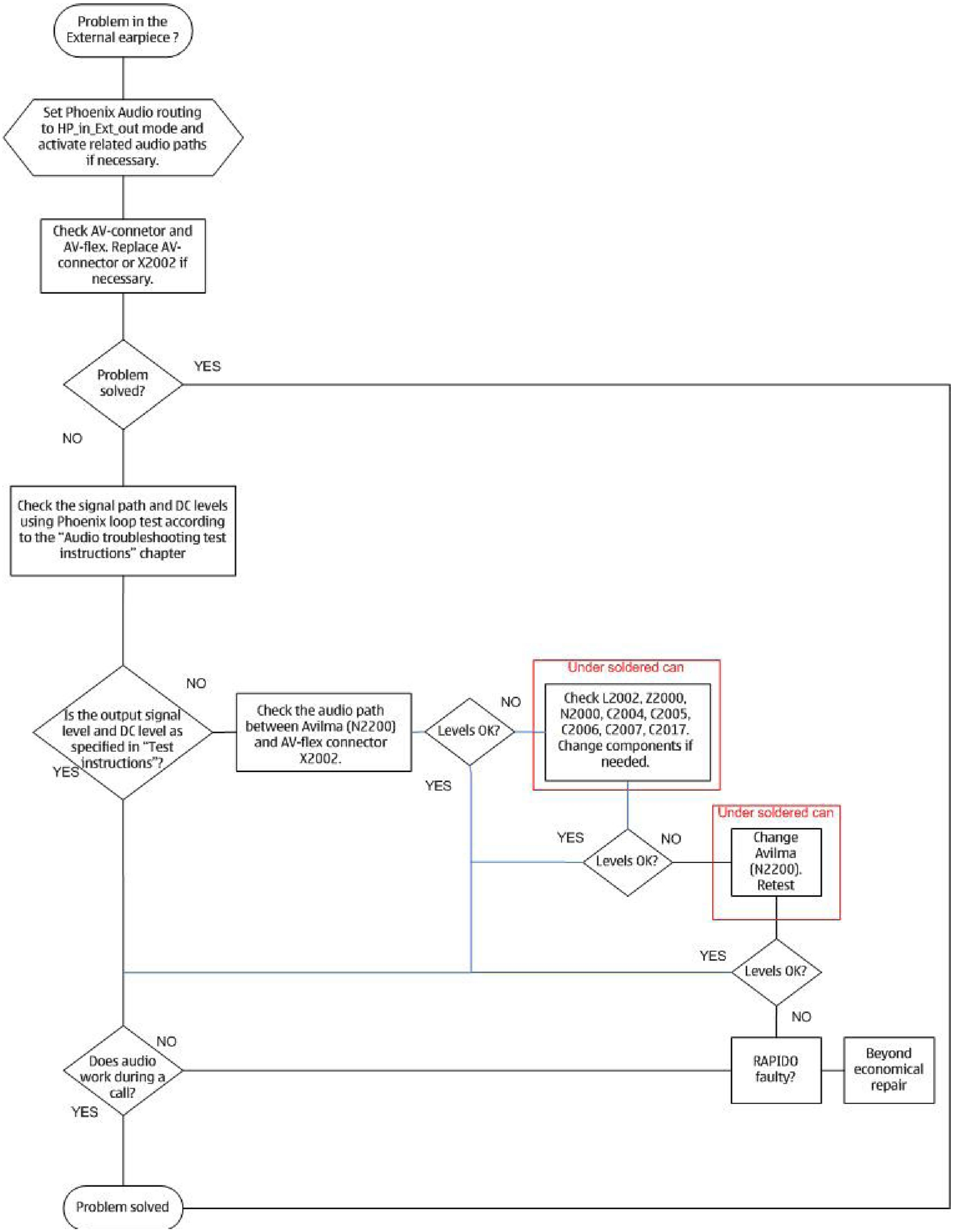
External headset microphone troubleshooting

Troubleshooting flow


Problem in the external microphone ?
Set Phoenix audio routing to Ext_in_HP_out and activate related audio paths if necessary
Check AV Connector and AV-flex. Replace it if needed.
Problem solved?
YES
NO
Measure DC voltage from the XMICP pad against GND
Is the bias voltage 2.1V measured from XMICP?
NO
Under soldered can
Check L2001, R2002, R2200, C2002, C2203, C2014, N2001 and replace if necessary. Retest
Bias voltage OK?
NO
Under soldered can
Change Avilma (N2200). Retest
YES
YES
Check the signal path using Phoenix loop test according to the "Audio troubleshooting test instructions" section
Is the output signal and DC level as specified in "Test instructions"?
NO
Under soldered can
Check L2001, R2002, R2200, C2002, C2203, C2014, N2001 and replace if necessary. Retest
Levels OK?
NO
Under soldered can
Change Avilma (N2200). Retest
Levels OK?
NO
RAPIDO faulty?
YES
Beyond economical repair
YES
YES
YES
Does audio work during call?
NO
RAPIDO faulty?
YES
Beyond economical repair
YES
Problem solved

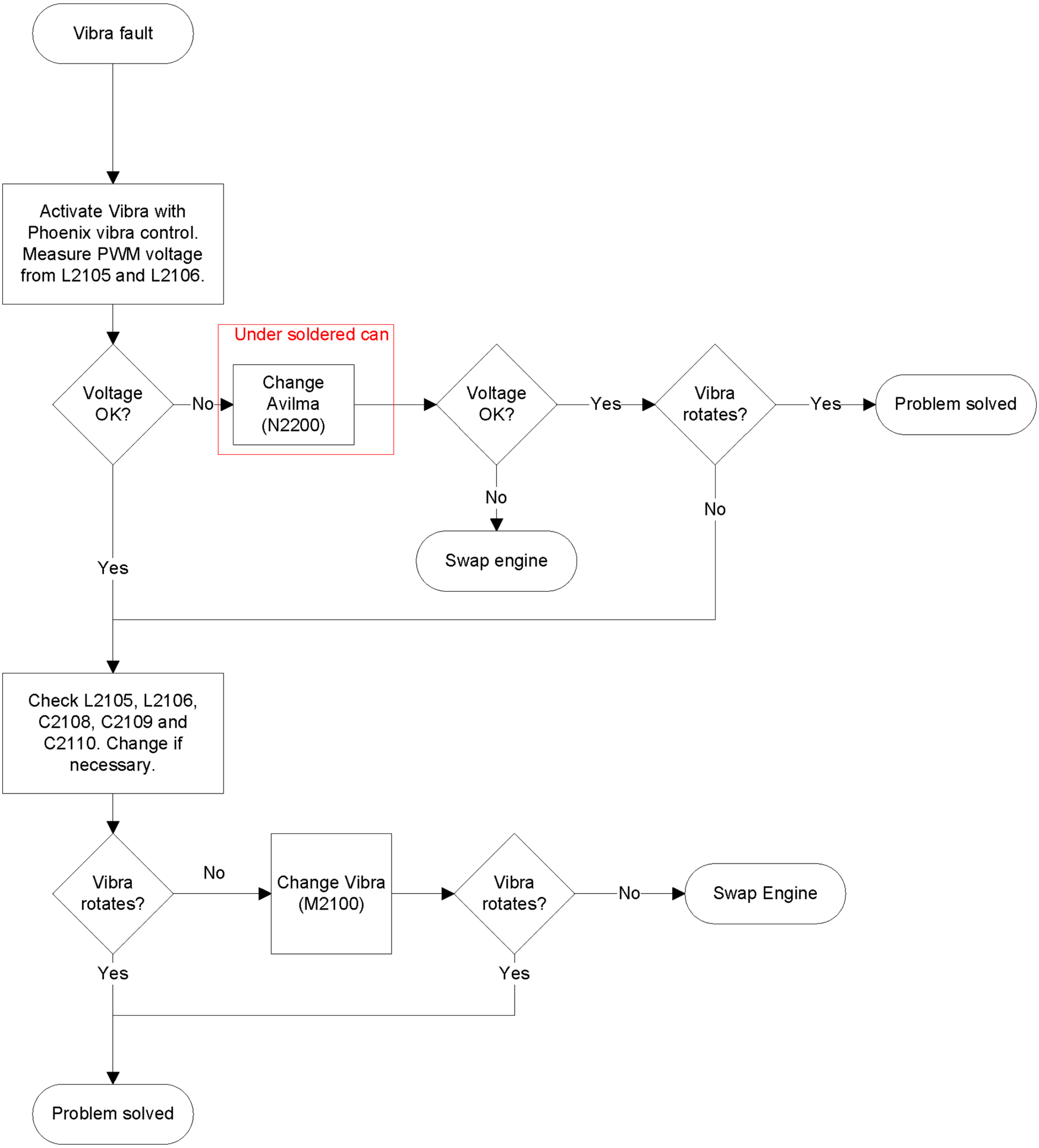
External headset earpiece troubleshooting

Troubleshooting flow


Problem in the External earpiece ?
Set Phoenix Audio routing to HP_in_Ext_out mode and activate related audio paths if necessary.
Check AV-connetor and AV-flex. Replace AV-connector or X2002 if necessary.
Problem solved?
YES
NO
Check the signal path and DC levels using Phoenix loop test according to the "Audio troubleshooting test instructions" chapter
Is the output signal level and DC level as specified in "Test instructions"?
NO
YES
Check the audio path between Avilma (N2200) and AV-flex connector X2002.
Levels OK?
NO
YES
Under soldered can
Check L2002, Z2000, N2000, C2004, C2005, C2006, C2007, C2017. Change components if needed.
YES
Levels OK?
NO
Under soldered can
Change Avilma (N2200). Retest
YES
Levels OK?
NO
Does audio work during a call?
NO
YES
RAPIDO faulty?
Beyond economical repair
Problem solved

Vibra troubleshooting

Troubleshooting flow


Vibra fault
Activate Vibra with Phoenix vibra control. Measure PWM voltage from L2105 and L2106.
Voltage OK?
No
Under soldered can
Change Avilma (N2200)
Voltage OK?
Yes
Vibra rotates?
Yes
Problem solved
No
Swap engine
No
Yes
Check L2105, L2106, C2108, C2109 and C2110. Change if necessary.
Vibra rotates?
No
Change Vibra (M2100)
Vibra rotates?
No
Swap Engine
Yes
Yes
Problem solved

Baseband manual tuning guide

Certificate restoring for BB5 products

Context

This procedure is performed when the device certificate is corrupted for some reason.

All tunings (RF & Baseband, UI) must be done after performing the certificate restoring procedure.

The procedure for certificate restoring is the following:

- Flash the phone with the latest available software using FPS-8 or FPS-10.

  Note: USB flashing does not work for a dead BB5 phone.
- Create a request file.
- Send the file to Nokia by e-mail. Use the following addresses depending on your location:
  - APAC: sydney.service@nokia.com
  - CHINA: repair.ams@nokia.com
  - E&A: salo.repair@nokia.com
  - AMERICAS: fls1.usa@nokia.com
- When you receive a reply from Nokia, carry out certificate restoring.
- Tune the phone completely.

  Note: SX-4 smart card is needed.
- If the phone resets after certificate restoring, reflash the phone again.

Required equipment and setup:

- *Phoenix* service software v 2007.19 or newer.
- The latest phone model specific *Phoenix* data package.
- PKD-1 dongle
- SX-4 smart card (Enables BB5 testing and tuning features)
- External smart card reader

  Note: The smart card reader is only needed when FPS-8 is used. FPS-10 has an integrated smart card reader.
- Activated FPS-8 flash prommer **OR** FPS-10 flash prommer
- Flash update package 03.18.004 or newer for FPS-8 or FPS-10 flash prommers
- CU-4 control unit
- USB cable from PC USB Port to CU-4 control unit
- Phone model specific adapter for CU-4 control unit
- PCS-1 cable to power CU-4 from external power supply
- XCS-4 modular cable between flash prommer and CU-4

  Note: CU-4 must be supplied with +12 V from an external power supply in all steps of certificate restoring.

Steps

1. Program the phone software.
   i Start *Phoenix* and login. Make sure the connection has been managed correctly for FPS-8 or FPS-10.

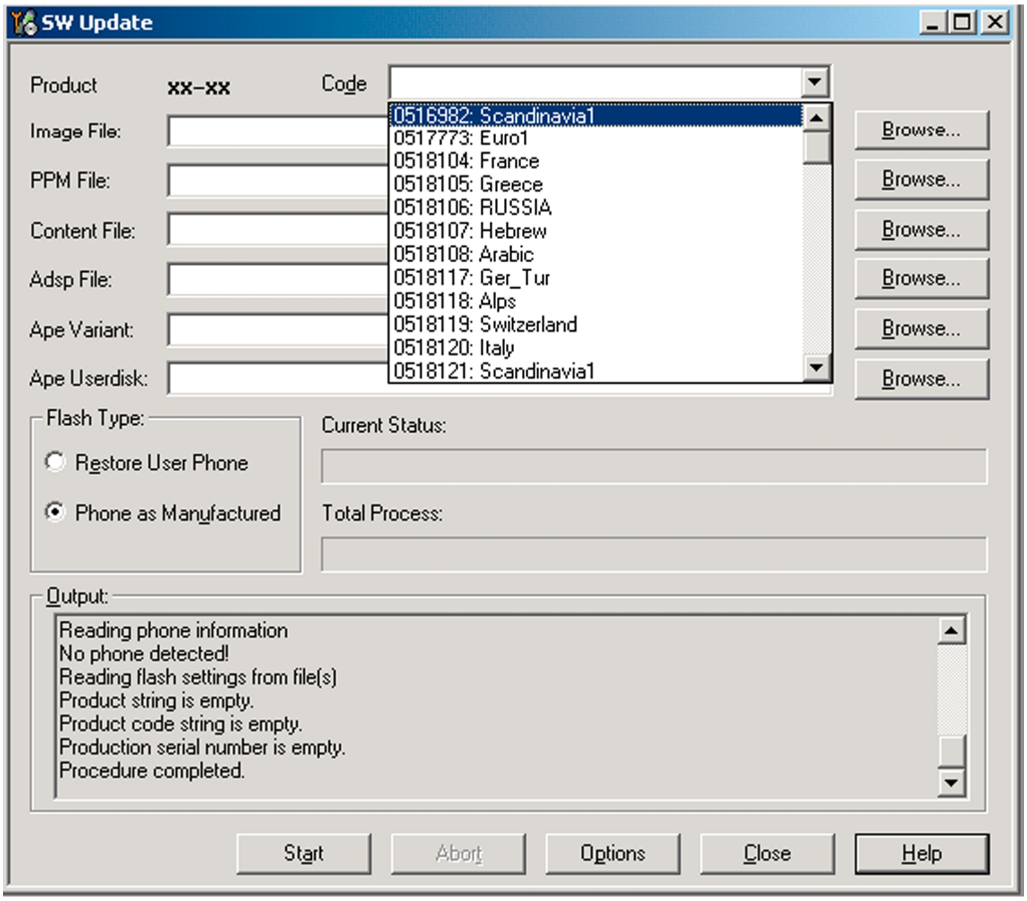
ii Update the phone MCU software to the latest available version.

If the new flash is empty and the phone cannot communicate with *Phoenix*, reflash the phone.

iii Choose the product manually from **File→Open Product** , and click **OK**.

Wait for the phone type designator (e.g. "RM-1") to be displayed in the status bar.

iv Go to **Flashing→SW Update** and wait until *Phoenix* reads the product data as shown in the following picture.


SW Update
Product
Code
Image File:
PPM File:
Content File:
Adsp File:
Ape Variant:
Ape Userdisk:
0516982: Scandinavia1
0517773: Euro1
0518104: France
0518105: Greece
0518106: RUSSIA
0518107: Hebrew
0518108: Arabic
0518117: Ger_Tur
0518118: Alps
0518119: Switzerland
0518120: Italy
0518121: Scandinavia1
Browse...
Browse...
Browse...
Browse...
Browse...
Browse...
Flash Type:
Restore User Phone
Phone as Manufactured
Current Status:
Total Process:
Output:
Start
Abort
Options
Close
Help

Product xx–xx

Flash Type:
○ Restore User Phone
● Phone as Manufactured

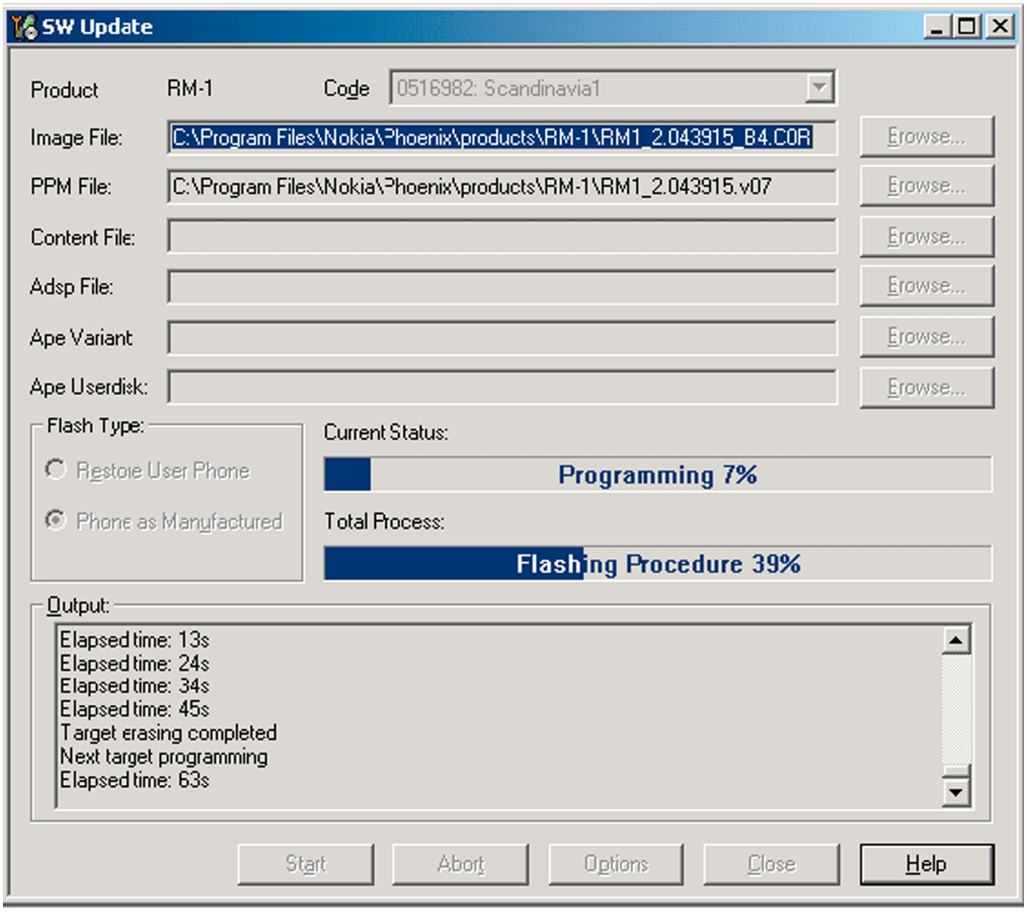
Output:

```
Reading phone information
No phone detected!
Reading flash settings from file(s)
Product string is empty.
Product code string is empty.
Production serial number is empty.
Procedure completed.
```

Product	is automatically set according to the phone support module which was opened manually, but the flash files cannot be found because the correct data cannot be read from the phone automatically.
Code	must be chosen manually, it determines the correct flash files to be used. Please choose the correct product code (can be seen in the phone type label) from the dropdown list.
Flash Type	must be set to **Phone as Manufactured**.

v To continue, click **Start**.

Progress bars and messages on the screen show actions during phone programming, please wait.


SW Update
Browse...
Flash Type:
Restore User Phone
Phone as Manufactured
Start
Abort
Options
Close
Help

Product RM-1 Code 0516982: Scandinavia1

Image File: C:\Program Files\Nokia\Phoenix\products\RM-1\RM1_2.043915_B4.C0R

PPM File: C:\Program Files\Nokia\Phoenix\products\RM-1\RM1_2.043915.v07

Content File:

Adsp File:

Ape Variant

Ape Userdisk:

○ Restore User Phone
● Phone as Manufactured

Current Status: Programming 7%

Total Process: Flashing Procedure 39%

Output:

```
Elapsed time: 13s
Elapsed time: 24s
Elapsed time: 34s
Elapsed time: 45s
Target erasing completed
Next target programming
Elapsed time: 63s
```

Programming is completed when Flashing Completed message is displayed.

The product type designator and MCU SW version are displayed in the status bar.

vi Close the *SW Update* window and then choose **File→Close Product** .

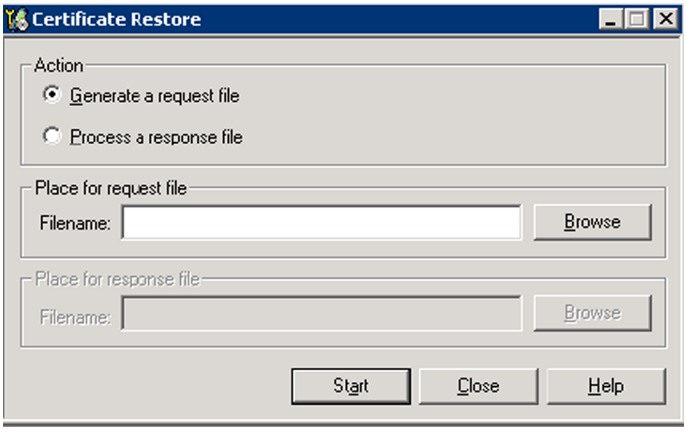
2. Create a *Request* file.

For this procedure, you must supply +12 V to CU-4 from an external power supply.

i To connect the phone with *Phoenix*, choose **File→Scan Product** .

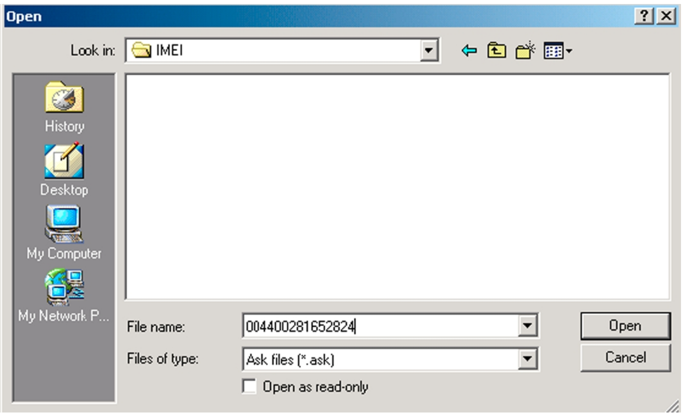
ii Choose **Tools→Certificate Restore** .

iii To choose a location for the request file, click **Browse**.


Certificate Restore
Action
Place for request file
Filename:
Browse
Place for response file
Filename:
Browse
Start
Close
Help

● Generate a request file
○ Process a response file

iv Name the file so that you can easily identify it, and click **Open**.


Open
History
Desktop
My Computer
My Network P...
Open
Cancel

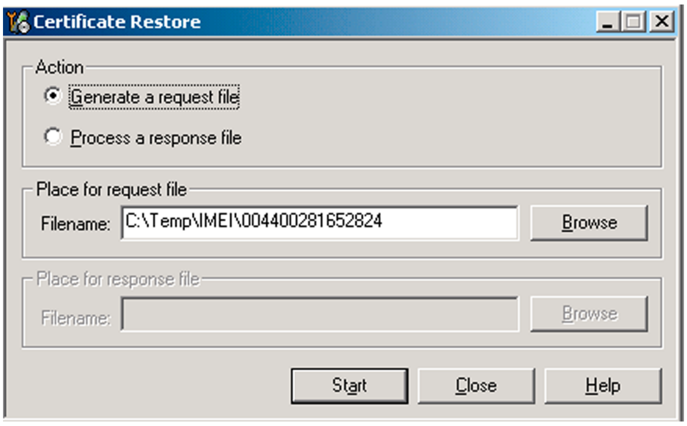
Look in: IMEI

File name: 004400281652824

Files of type: Ask files (*.ask)

☐ Open as read-only

The name of the file and its location are shown.


Certificate Restore
Browse
Browse
Start
Close
Help

Action

● Generate a request file

○ Process a response file

Place for request file

Filename: C:\Temp\IMEI\004400281652824

Place for response file

Filename:

v To create the *Request* file, click **Start**.

vi When the file for certificate restore has been created, send it to Nokia as an e-mail attachment.

3. Restore certificate.

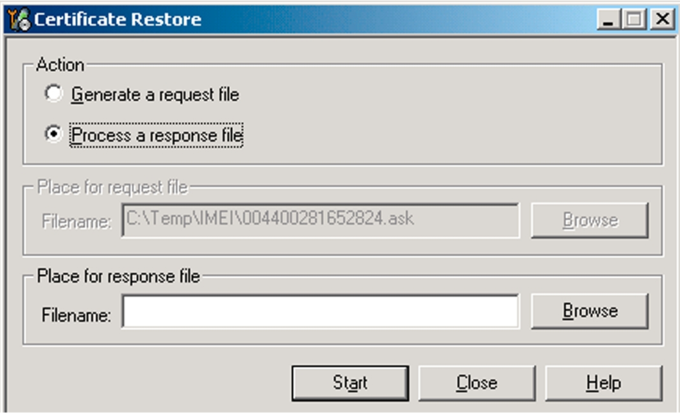
For this procedure, you must supply +12 V to CU-4 from an external power supply.

i Save the reply file sent by Nokia to your computer.

ii Start *Phoenix* service software.

iii Choose **File→Scan Product** .

iv From the **Tools** menu, choose **Certificate Restore** and select **Process a response file** in the *Action* pane.



Certificate Restore
Action
Place for request file
Place for response file
Browse
Browse
Start
Close
Help

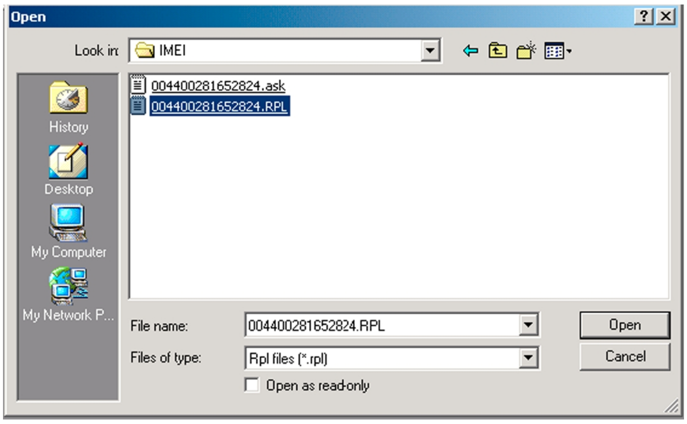
○ Generate a request file
● Process a response file

Place for request file — Filename: C:\Temp\IMEI\004400281652824.ask

Place for response file — Filename:

v To choose the location where response file is saved, click **Browse**.

vi Click **Open**.



Open
History
Desktop
My Computer
My Network P...
Open
Cancel

Look in: IMEI

004400281652824.ask
004400281652824.RPL

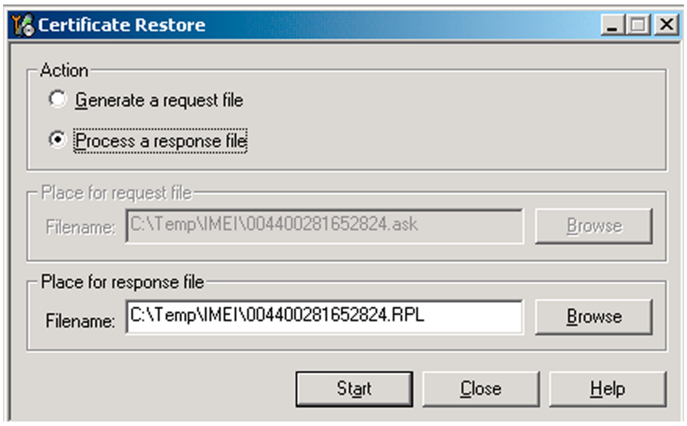
File name: 004400281652824.RPL

Files of type: Rpl files (*.rpl)

☐ Open as read-only

The name of the file and the path where it is located are shown.

vii To write the file to phone, click **Start**.



Certificate Restore
Action
Place for request file
Place for response file
Browse
Browse
Start
Close
Help

○ Generate a request file
● Process a response file

Place for request file — Filename: C:\Temp\IMEI\004400281652824.ask

Place for response file — Filename: C:\Temp\IMEI\004400281652824.RPL

Next actions

After a successful rewrite, you must retune the phone completely by using *Phoenix* tuning functions.

Important: Perform all tunings: RF, BB, and UI.

Energy management calibration

Energy management calibration is not needed, because there are no serviceable components which may affect to EM calibration parameters.

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4 — RF troubleshooting

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General RF troubleshooting

Introduction to RF troubleshooting

Soldered metal shieldings and components below them are not allowed to be changed or removed. The purpose of the following troubleshooting document is only to identify possible RF faults and advice how to tune the phone if it is necessary.

All measurements should be done using:

- spectrum analyser with a high-frequency high-impedance passive probe (LO-/reference frequencies and RF power levels)
- oscilloscope with a 10:1 probe (DC-voltages and low frequency signals)

> **Caution:** A mobile phone WCDMA transmitter should never be tested with full Tx power, if there is no possibility to perform the measurements in a good performance RF-shielded room. Even low power WCDMA transmitters may disturb nearby WCDMA networks and cause problems to 3G cellular phone communication in wide area. WCDMA Tx measurements should be performed at least in an RF-shielded box and never with higher Tx power level than 0 dBm! Test full WCDMA Tx power only in RF-shielded environment.
>
> Also all measurements with an RF coupler should be performed in RF shielded environment because nearby base stations can disturb sensitive receiver measurements. If there is no possibility to use RF shielded environment, it should be checked that there are no transmissions on the same frequencies as used in the tests.

The RF section of the phone is built around one RF ASIC N7505. There are also GSM TXFEM (integrated PA and front end module) N7520 and WCDMA PA N7540 on board.

The WCDMA PA needs variable supply voltage to work properly, and therefore there is a switched mode power supply component added to the PWB (N7541).

Most RF semiconductors are static discharge sensitive. ESD protection must be taken care of during repair (ground straps and ESD soldering irons). The RF ASICs, both PAs and SMPS are moisture sensitive, so parts must be pre-baked prior to soldering.

RF key components

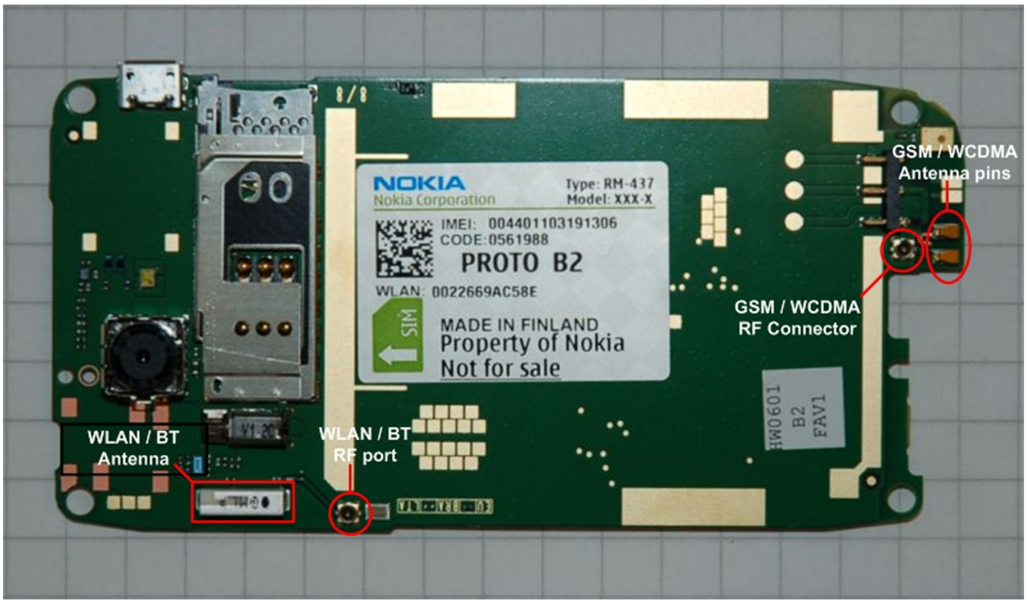


Figure 14 RF component layout bottom

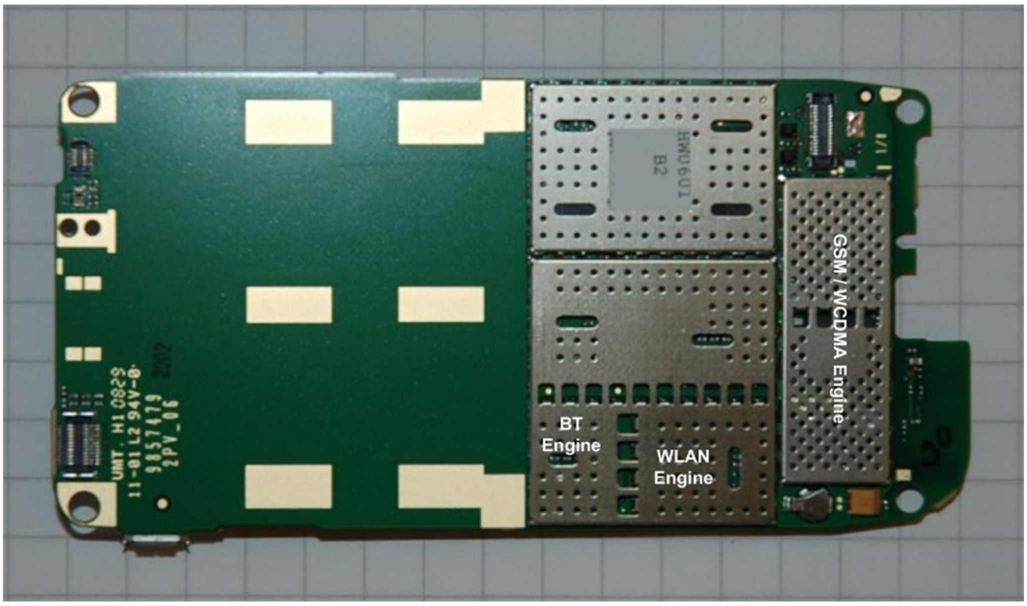
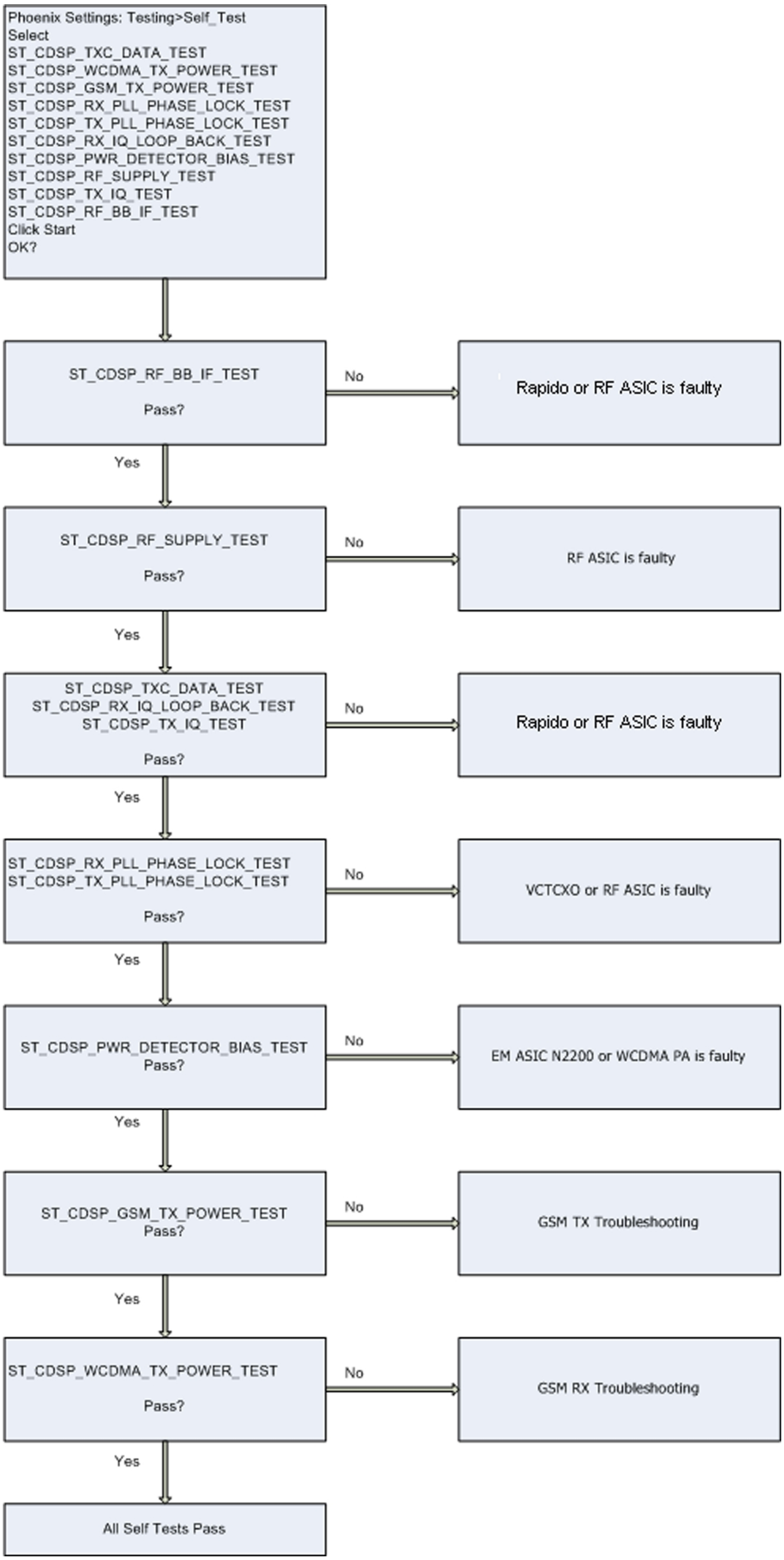

BT
Engine
WLAN
Engine
GSM / WCDMA Engine

Figure 15 RF component layout top

RF self test troubleshooting

Troubleshooting flow


Phoenix Settings: Testing>Self_Test
Select
ST_CDSP_TXC_DATA_TEST
ST_CDSP_WCDMA_TX_POWER_TEST
ST_CDSP_GSM_TX_POWER_TEST
ST_CDSP_RX_PLL_PHASE_LOCK_TEST
ST_CDSP_TX_PLL_PHASE_LOCK_TEST
ST_CDSP_RX_IQ_LOOP_BACK_TEST
ST_CDSP_PWR_DETECTOR_BIAS_TEST
ST_CDSP_RF_SUPPLY_TEST
ST_CDSP_TX_IQ_TEST
ST_CDSP_RF_BB_IF_TEST
Click Start
OK?
ST_CDSP_RF_BB_IF_TEST
Pass?
No
Rapido or RF ASIC is faulty
Yes
ST_CDSP_RF_SUPPLY_TEST
Pass?
No
RF ASIC is faulty
Yes
ST_CDSP_TXC_DATA_TEST
ST_CDSP_RX_IQ_LOOP_BACK_TEST
ST_CDSP_TX_IQ_TEST
Pass?
No
Rapido or RF ASIC is faulty
Yes
ST_CDSP_RX_PLL_PHASE_LOCK_TEST
ST_CDSP_TX_PLL_PHASE_LOCK_TEST
Pass?
No
VCTCXO or RF ASIC is faulty
Yes
ST_CDSP_PWR_DETECTOR_BIAS_TEST
Pass?
No
EM ASIC N2200 or WCDMA PA is faulty
Yes
ST_CDSP_GSM_TX_POWER_TEST
Pass?
No
GSM TX Troubleshooting
Yes
ST_CDSP_WCDMA_TX_POWER_TEST
Pass?
No
GSM RX Troubleshooting
Yes
All Self Tests Pass

Receiver troubleshooting

Introduction to receiver (RX) troubleshooting

RX can be tested by making a phone call or in local mode. For the local mode testing, use Phoenix service software.

The main RX troubleshooting measurement is RSSI reading. This test measures the signal strength of the received signal. For GSM RSSI measurements, see GSM RX chain activation for manual measurements / GSM RSSI measurement (page 4–8). For a similar test in WCDMA mode, see WCDMA RSSI measurement (page 4–10).

GSM RX chain activation for manual measurements/GSM RSSI measurement

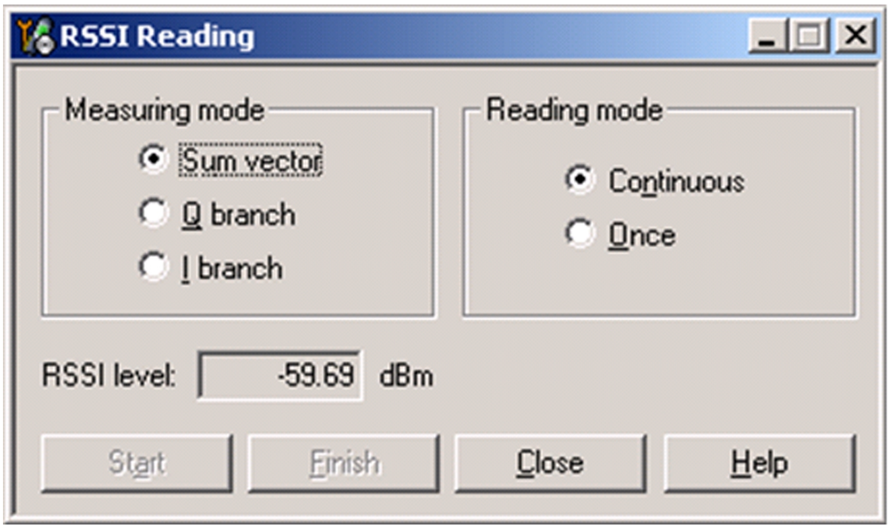
Prerequisites

Make the following settings in Phoenix service software:

Setting	GSM850	GSM900	GSM1800	GSM1900
Phoenix Channel	190	37	700	661
Signal generator to antenna connector	881.66771MHz (67.71kHz offset) at -60dBm	942.46771MHz (67.71kHz offset) at -60dBm	1842.86771MHz (67.71kHz offset) at -60dBm	1960.06771MHz (67.71kHz offset) at -60dBm

Steps

1. Set the phone to local mode.
2. Activate RSSI reading in Phoenix (**Testing→GSM→RSSI reading**)



RSSI Reading

Measuring mode
● Sum vector
○ Q branch
○ I branch

Reading mode
● Continuous
○ Once

RSSI level: -59.69 dBm

Results

The reading should reflect the level of the signal generator (-losses) +/- 5 dB.

When varying the level in the range -30 to -102 dBm the reading should then follow within +/-5 dB.

WCDMA RX chain activation for manual measurement

Prerequisites

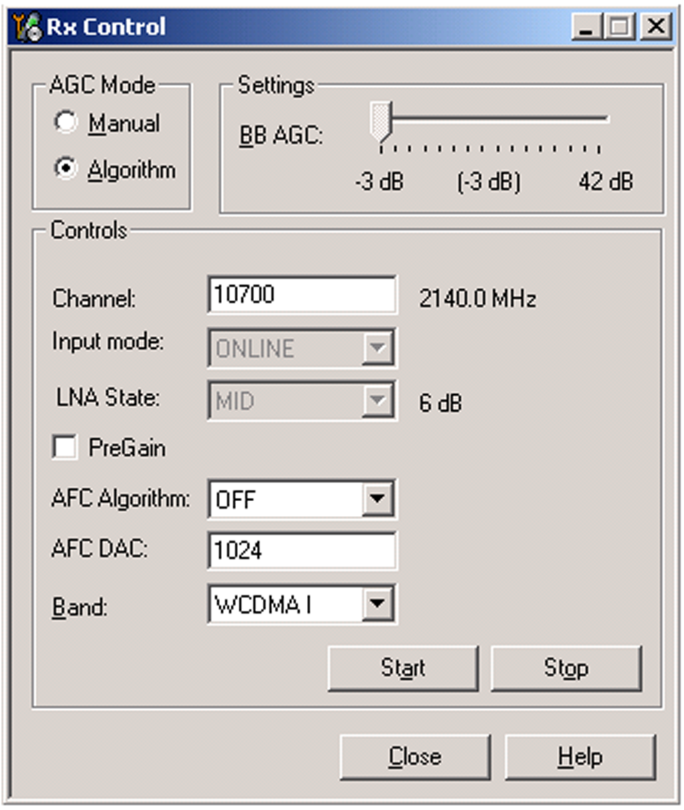
Make the following settings in Phoenix service software:

Setting	WCDMA I	WCDMA II	WCDMA VIII	WCDMA V
Phoenix channel	10700	9800	3012	4408
Signal generator to antenna connector	2141.0 MHz	1961.0 MHz	943.4 MHz	882.6 MHz

Note: The phone has two WCDMA bands. The testing and tuning procedures are same for both bands. Just select band I or VIII (RM-437), II or V (RM-449), I or V (RM-450).

Steps

1. Via Phoenix Testing menu, choose **WCDMA/RX Control**.
2. In the RX control window, make the following settings:



AGC Mode: ○ Manual ● Algorithm

BB AGC: -3 dB (-3 dB) 42 dB

Channel: 10700 2140.0 MHz

Input mode: ONLINE

LNA State: MID 6 dB

☐ PreGain

AFC Algorithm: OFF

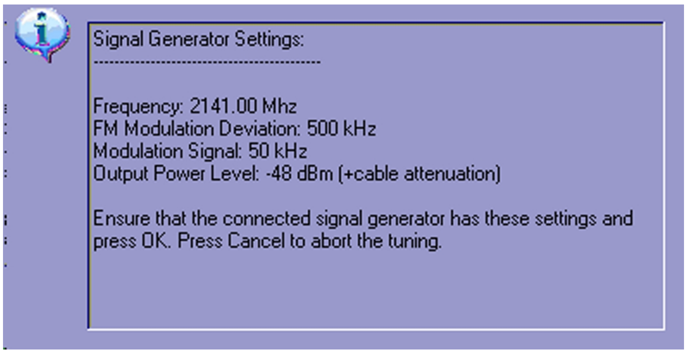
AFC DAC: 1024

Band: WCDMA I

3. Click **Start** to activate the settings.

   If the settings are changed later on (for example, change of channel) you have to click **Stop** and **Start** again.

   Note: Clicking **Stop** also disables TX control if it was active.
4. Set the following RF generator settings:



Signal Generator Settings:

Frequency: 2141.00 Mhz
FM Modulation Deviation: 500 kHz
Modulation Signal: 50 kHz
Output Power Level: -48 dBm (+cable attenuation)

Ensure that the connected signal generator has these settings and press OK. Press Cancel to abort the tuning.

Figure 16 WCDMA RX generator settings

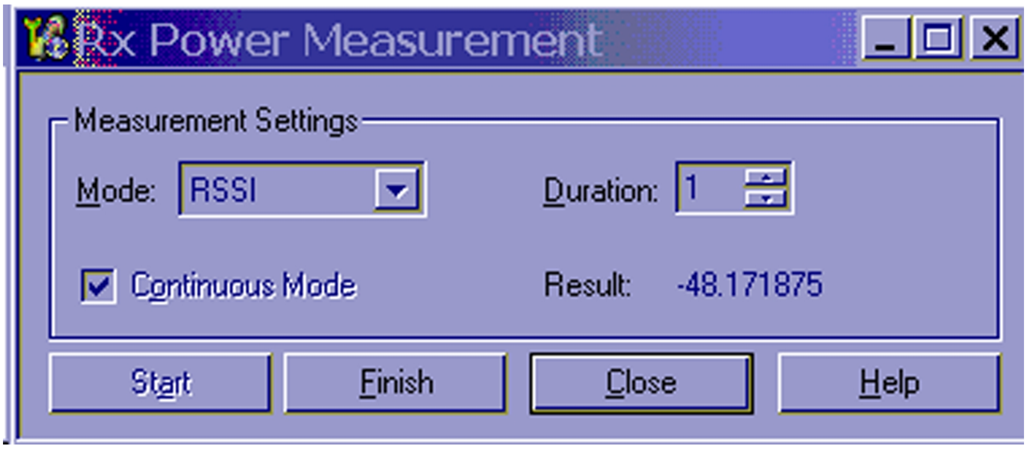
WCDMA RSSI measurement

Prerequisites

WCDMA RX must be activated before RSSI can be measured. For instructions, please refer to WCDMA RX chain activation (page 4– 0).

Steps

1. From the Phoenix testing menu, select **WCDMA→RX Power measurement**
2. In the RX Power measurement window, select:
   - Mode: RSSI
   - Continuous mode



Measurement Settings
Mode: RSSI
Duration: 1
☑ Continuous Mode
Result: -48.171875

3. Click **Start** to perform the measurement.

Transmitter troubleshooting

General instructions for transmitter (TX) troubleshooting

Please note the following before performing transmitter tests:

- TX troubleshooting requires TX operation.
- Do not transmit on frequencies that are in use!
- The transmitter can be controlled in local mode for diagnostic purposes.
- The most useful Phoenix tool for GSM transmitter testing is “RF Controls”; in WCDMA transmitter testing the best tool is “TX Control”.
- Remember that re-tuning is not a fix! Phones are tuned correctly in production

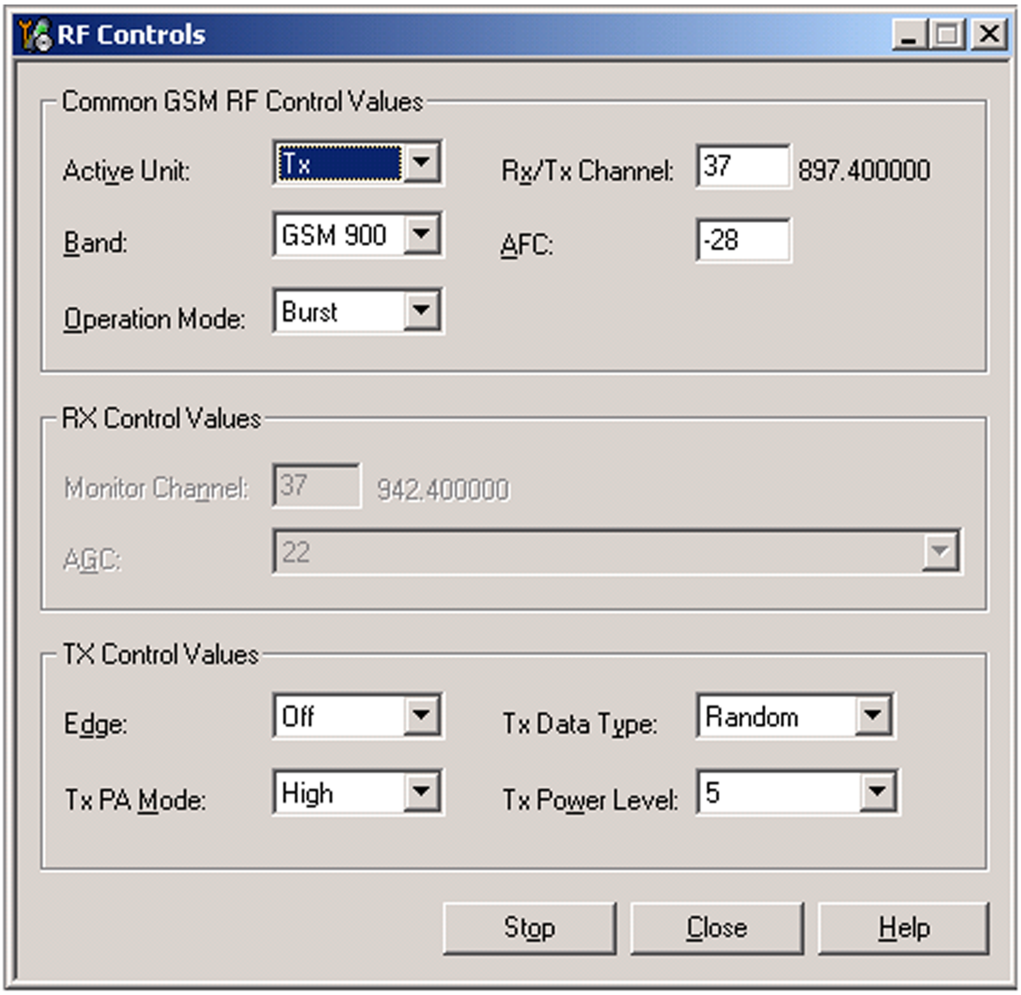
Note: Never activate the GSM or WCDMA transmitter without a proper antenna load. Always connect a 50 Ω load to the RF connector (antenna, RF-measurement equipment or at least a 2 W dummy load); otherwise the GSM or WCDMA Power amplifier (PA) may be damaged.

GSM transmitter troubleshooting

Steps

1. Set the phone to local mode.
2. Activate RF controls in Phoenix (**Testing→GSM→Rf Controls**).

   Use the following settings:



Common GSM RF Control Values

Active Unit: Tx
Band: GSM 900
Operation Mode: Burst
Rx/Tx Channel: 37 897.400000
AFC: -28

RX Control Values

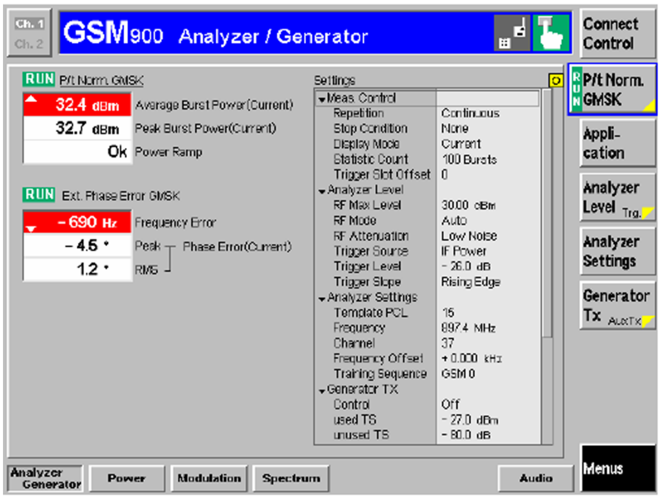
Monitor Channel: 37 942.400000
AGC: 22

TX Control Values

Edge: Off
Tx PA Mode: High
Tx Data Type: Random
Tx Power Level: 5

3. Check the basic TX parameters (i.e. power, phase error, modulation and switching spectrum), using a communication analyser in non-signalling mode (for example CMU200).

Analyser settings



GSM900 Analyzer / Generator

RUN P/t Norm. GMSK

32.4 dBm	Average Burst Power(Current)
32.7 dBm	Peak Burst Power(Current)
Ok	Power Ramp

RUN Ext. Phase Error GMSK

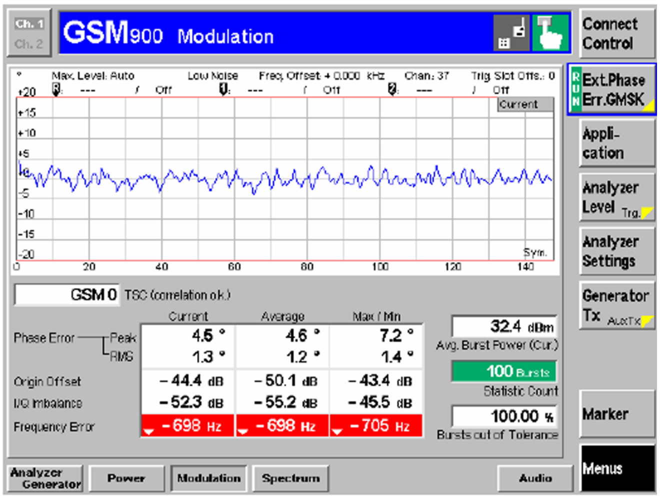
– 690 Hz	Frequency Error
– 4.5 °	Peak – Phase Error(Current)
1.2 °	RMS

Settings

Meas. Control	
Repetition	Continuous
Stop Condition	None
Display Mode	Current
Statistic Count	100 Bursts
Trigger Slot Offset	0
Analyzer Level	
RF Max Level	30.00 dBm
RF Mode	Auto
RF Attenuation	Low Noise
Trigger Source	IF Power
Trigger Level	– 26.0 dB
Trigger Slope	Rising Edge
Analyzer Settings	
Template PCL	15
Frequency	897.4 MHz
Channel	37
Frequency Offset	+ 0.000 kHz
Training Sequence	GSM 0
Generator TX	
Control	Off
used TS	– 27.0 dBm
unused TS	– 80.0 dB

Ch. 1
Ch. 2
Connect Control
P/t Norm. GMSK
Appli-cation
Analyzer Level Trg.
Analyzer Settings
Generator Tx AuxTx
Menus
Analyzer Generator
Power
Modulation
Spectrum
Audio

Phase error



GSM900 Modulation

Max. Level: Auto Low Noise Freq. Offset: + 0.000 kHz Chan.: 37 Trig. Slot Offs.: 0

GSM 0 TSC (correlation o.k.)

		Current	Average	Max / Min
Phase Error	Peak	4.5 °	4.6 °	7.2 °
	RMS	1.3 °	1.2 °	1.4 °
Origin Offset		– 44.4 dB	– 50.1 dB	– 43.4 dB
I/Q Imbalance		– 52.3 dB	– 55.2 dB	– 45.5 dB
Frequency Error		– 698 Hz	– 698 Hz	– 705 Hz

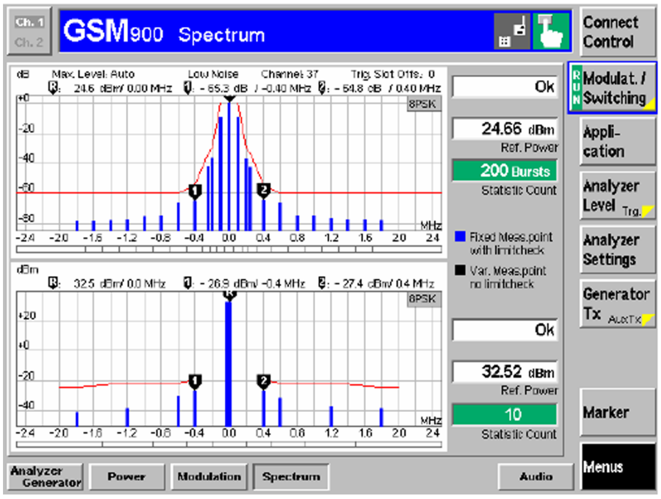
32.4 dBm Avg. Burst Power (Cur.)

100 Bursts Statistic Count

100.00 % Bursts out of Tolerance

+20
+15
+10
+5
-5
-10
-15
-20
0
20
40
60
80
100
120
140
Sym.
Current
Connect Control
Ext.Phase Err.GMSK
Appli-cation
Analyzer Level Trg.
Analyzer Settings
Generator Tx AuxTx
Marker
Menus
Analyzer Generator
Power
Modulation
Spectrum
Audio

Modulation/Switching spectrum



GSM900 Spectrum

Max. Level: Auto Low Noise Channel: 37 Trig. Slot Offs.: 0

Ok

24.66 dBm Ref. Power

200 Bursts Statistic Count

Fixed Meas.point with limitcheck

Var. Meas.point no limitcheck

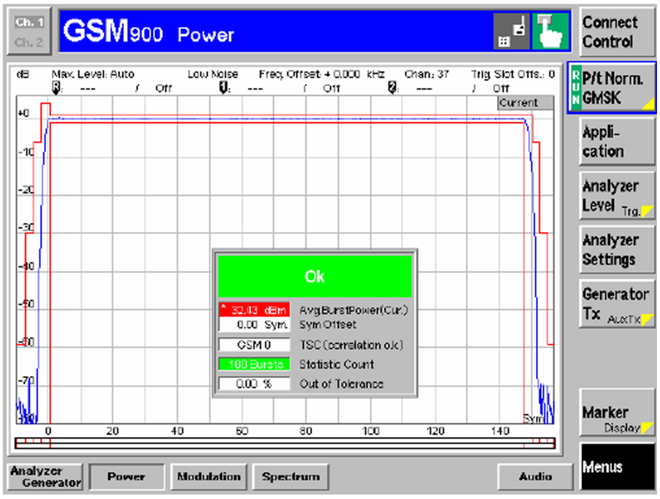
Ok

32.52 dBm Ref. Power

10 Statistic Count

dB
24.6 dBm/ 0.00 MHz
- 65.3 dB / -0.40 MHz
- 64.8 dB / 0.40 MHz
8PSK
MHz
-24
-20
-16
-12
-08
-04
00
04
08
12
16
20
24
dBm
32.5 dBm/ 0.0 MHz
- 26.9 dBm/ -0.4 MHz
- 27.4 dBm/ 0.4 MHz
Connect Control
Modulat. / Switching
Appli-cation
Analyzer Level Trg.
Analyzer Settings
Generator Tx AuxTx
Marker
Menus
Analyzer Generator
Power
Modulation
Spectrum
Audio

Power/Burst



GSM900 Power

Max. Level: Auto Low Noise Freq. Offset: + 0.000 kHz Chan.: 37 Trig. Slot Offs.: 0

Ok

32.43 dBm	Avg.BurstPower(Cur.)
0.00 Sym.	Sym.Offset
GSM 0	TSC (correlation o.k.)
100 Bursts	Statistic Count
0.00 %	Out of Tolerance

dB
+0
-10
-20
-30
-40
-50
-60
-70
0
20
40
60
80
100
120
140
Sym.
Current
Connect Control
P/t Norm. GMSK
Appli-cation
Analyzer Level Trg.
Analyzer Settings
Generator Tx AuxTx
Marker Display
Menus
Analyzer Generator
Power
Modulation
Spectrum
Audio

Figure 17 Typical readings

4. Change the power level (RF controls) and make sure the power reading follows accordingly.

Next actions

You can troubleshoot the GSM transmitter for each GSM band separately, one band at a time. If you want to troubleshoot GSM850, GSM1800 or GSM1900, change the band with the RF controls and set the communication analyser accordingly.

Checking antenna functionality

Antenna overview

The main antenna has one antenna element (GSM and WCDMA).

In the GSM/WCDMA antenna there is one feed and one ground contact.

The BT/WLAN antenna is a discrete component on PWB.

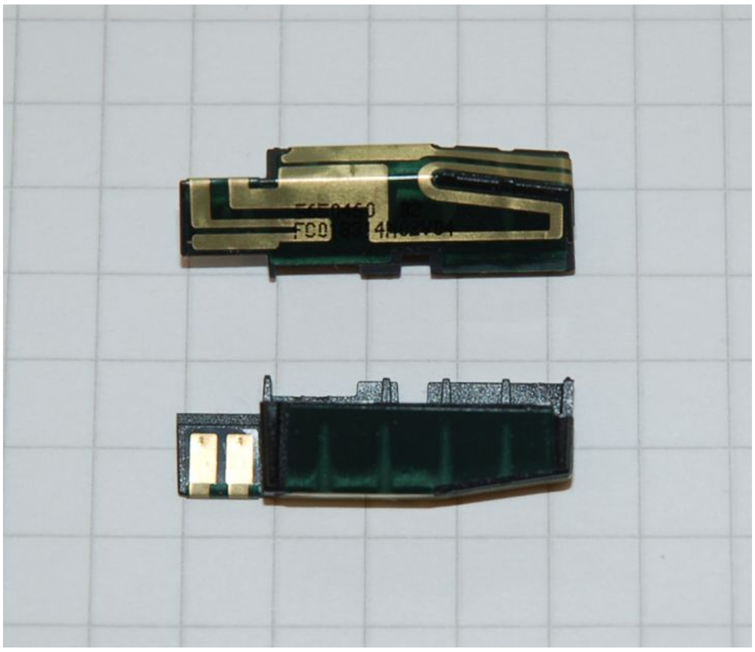


Figure 18 Antenna element

Main antenna functionality

The main GSM+WCDMA antenna is functioning normally when the feed and GND C-clips take proper contact to the PWB, and the antenna foil is visually intact in the antenna frame.

The main antenna functionality must also be checked by measuring the transmitted power with RF coupler at GSM900 channel 124.

WCDMA transmitter troubleshooting

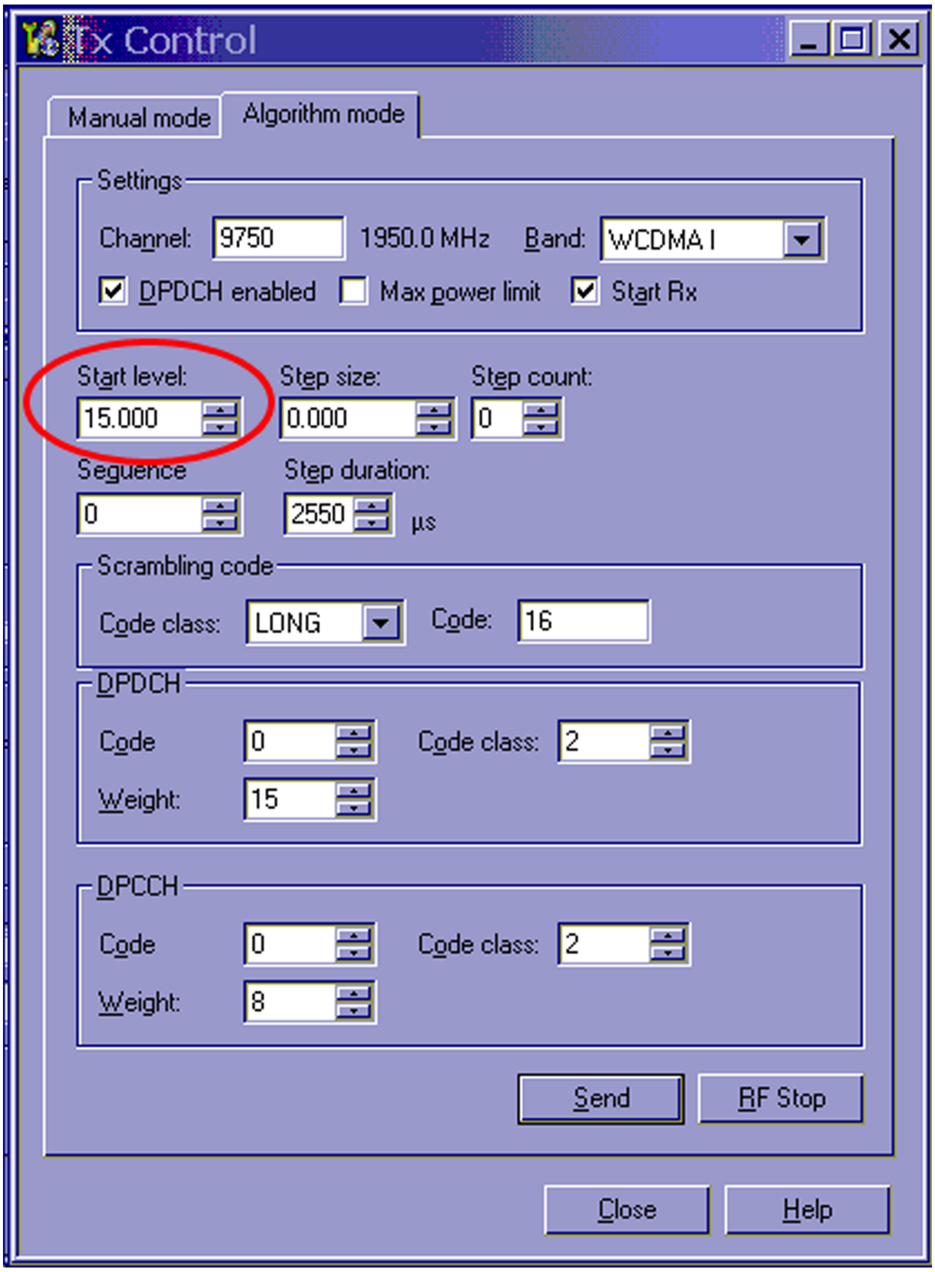
Context

WCDMA TX channel numbers and frequencies:

Channel	Channel number / Frequency			
	WCDMA I (2100)	WCDMA II (1900)	WCDMA VIII (900)	WCDMA V (850)
low	9612 / 1922.4 MHz	9262 / 1852.4 MHz	2712 / 882.4 MHz	4132 / 826.4 MHz
mid	9750 / 1950.0 MHz	9400 / 1880.0 MHz	2787 / 897.4 MHz	4183 / 836.6 MHz
high	9888 / 1977.6 MHz	9538 / 1907.6 MHz	2863 / 912.6 MHz	4233 / 846.6 MHz

Steps

1. Set the phone to local mode.
2. In Phoenix, select **Testing→WCDMA→TX control** .
3. Use the following settings in the TX control window:



Settings

Channel: 9750 1950.0 MHz Band: WCDMA I

☑ DPDCH enabled ☐ Max power limit ☑ Start Rx

Start level: 15.000

Step size: 0.000

Step count: 0

Sequence 0

Step duration: 2550 µs

Scrambling code

Code class: LONG Code: 16

DPDCH

Code 0 Code class: 2

Weight: 15

DPCCH

Code 0 Code class: 2

Weight: 8

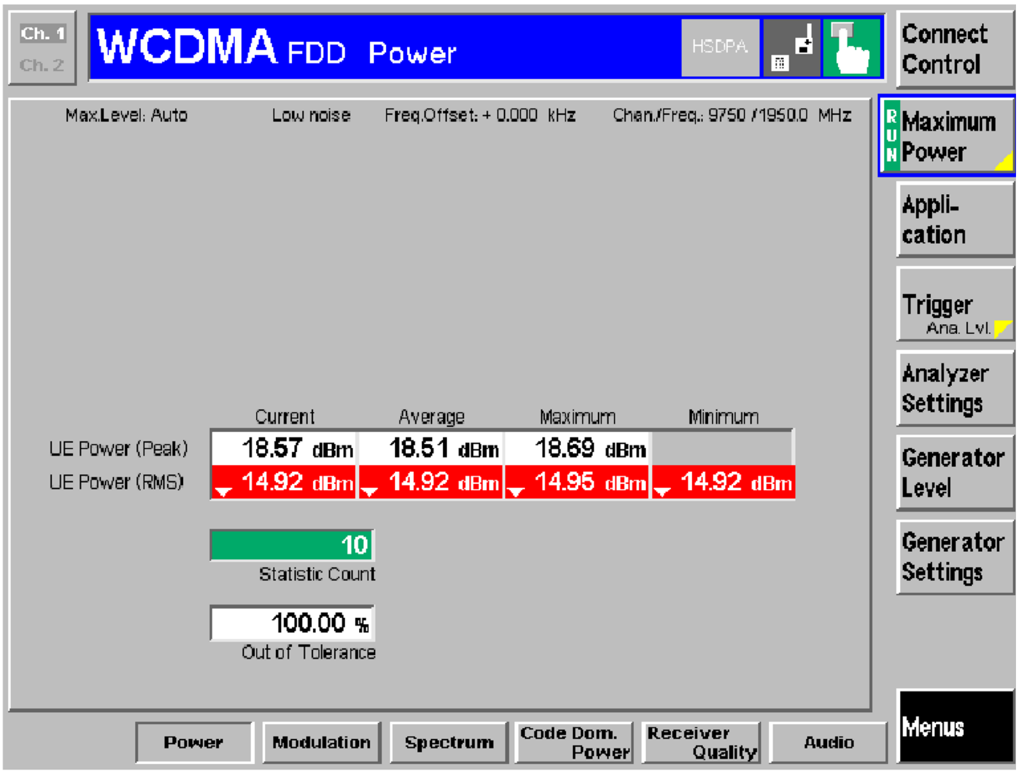
Figure 19 Phoenix WCDMA TX control window

Note: Use the **Start level** option to set the TX power level.

4. Click **Send** to enable the settings and activate TX.

   If settings are changed (eg. new channel), you have to click **RF Stop** and **Send** again.

5. Use R&S CMU200 cellular tester with the following settings to check WCDMA power:
   - Select WCDMA FDD / Non-Signalling mode.
   - Push "Connect control" and select sheet "Analyzer".
   - Select RF Channel or Frequency (same than in Phoenix).
   - Select sheet "RF" and set jig and cable loss used.
   - Push "Connect control" or escape button on the tester.
   - Select "Power sheet" if not selected automatically and measure power.


Ch. 1
Ch. 2
WCDMA FDD Power
HSDPA
Connect Control
RUN
Maximum Power
Appli-cation
Trigger
Ana. Lvl.
Analyzer Settings
Generator Level
Generator Settings
Menus
Power
Modulation
Spectrum
Code Dom. Power
Receiver Quality
Audio

Max.Level: Auto   Low noise   Freq.Offset: + 0.000 kHz   Chan./Freq.: 9750 / 1950.0 MHz

	Current	Average	Maximum	Minimum
UE Power (Peak)	18.57 dBm	18.51 dBm	18.69 dBm	
UE Power (RMS)	14.92 dBm	14.92 dBm	14.95 dBm	14.92 dBm

10
Statistic Count

100.00 %
Out of Tolerance

Figure 20 WCDMA power window

RF tunings

Introduction to RF tunings

Important: Only perform RF tunings if:

- one or more of the RF components have been replaced
- flash memory chip is replaced or corrupted.

RF calibration is always performed with the help of a product-specific module jig, never with an RF coupler. Using an RF coupler in the calibration phase will cause a complete mistuning of the RF part.

Important: After RF component replacements, **always** use autotuning. Manual tunings are only required in rare cases.

Cable and adapter losses

RF cables and adapters have some losses. They have to be taken into account when the phone is tuned. As all RF losses are frequency dependent, the user has to act very carefully and understand the measurement setup.

The following table shows the RF attenuation values for product specific module jig:

Band	Channel number / Frequency				
	Tuning channel	Attenuation RX	Tolerance RX	Attenuation TX	Tolerance TX
GSM 850	190	-0,1	+/- 0.1	-0,1	+/- 0.1
GSM900	37	-0,1	+/- 0.1	-0,1	+/- 0.1
GSM1800	700	-0,2	+/- 0.1	-0,2	+/- 0.1

Band	Channel number / Frequency				
GSM1900	661	-0,2	+/- 0.1	-0,2	+/- 0.1
WCDMA I (2100)	10700 / 9750	-0,2	+/- 0.1	-0,2	+/- 0.1
WCDMA II (1900)	9800 / 9400	-0,2	+/- 0.1	-0,2	+/- 0.1
WCDMA VIII (900)	3012 / 2787	-0,1	+/- 0.1	-0,1	+/- 0.1
WCDMA V (850)	4408 / 4183	-0,1	+/- 0.1	-0,1	+/- 0.1

Autotuning for BB5

This phone can be tuned automatically.

Autotune is designed to align the phone's RF part easier and faster. It performs calibrations, tunings and measurements of RX and TX. The results are displayed and logged in a result file, if initiated.

Hardware set up

Hardware requirements for auto tuning:

- PC (Windows 2000/XP) with GPIB card
- Power supply
- Product specific module jig
- Cables: XRF-1 (RF cable), USB cable, GBIP cable and DAU-9S
- Signal analyser (TX), signal generator (RX) and RF-splitter *or* one device including all.

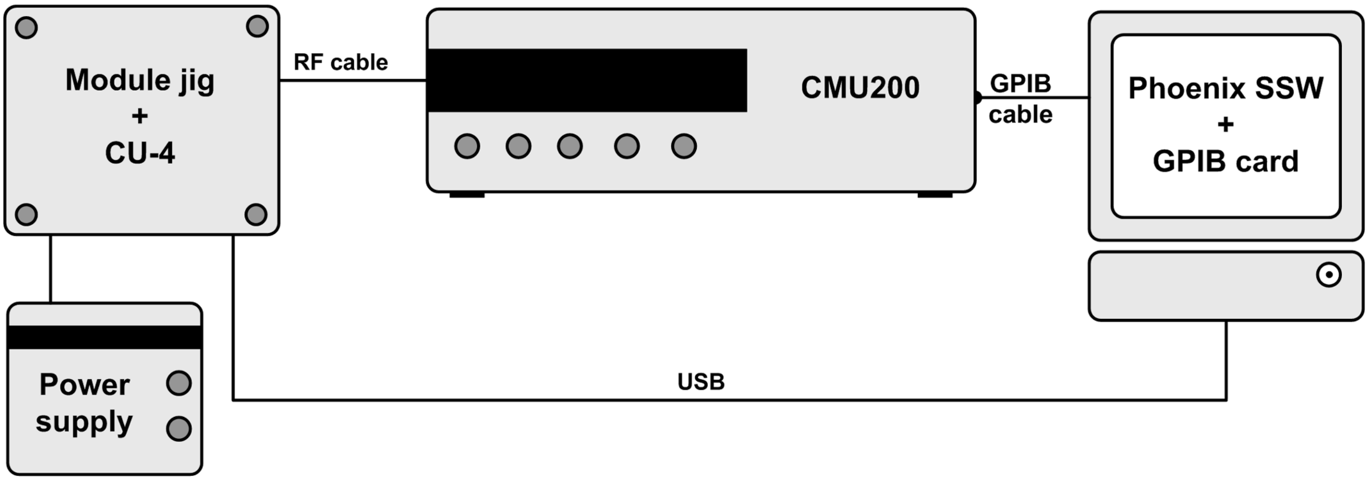


Figure 21 Auto tuning concept with CMU200

Phoenix preparations

Install the phone-specific data package. This defines the phone-specific settings.

Auto tuning procedure

1 Make sure the phone (in the jig) is connected to the equipment. Else, some menus will not be shown in Phoenix.

2 To go to autotune, select *Tuning (Alt-U)* > *Auto-Tune (Alt-A)* from the menu.

3 Remember to set the correct attenuation values before autotuning.

4 To start autotuning, click the *Tune* button.

System mode independent manual tunings

RF channel filter calibration

Context

Rf channel filter calibration tunes the internal low pass filters of the RF ASIC, that limit the bandwidth of BB IQ signals.

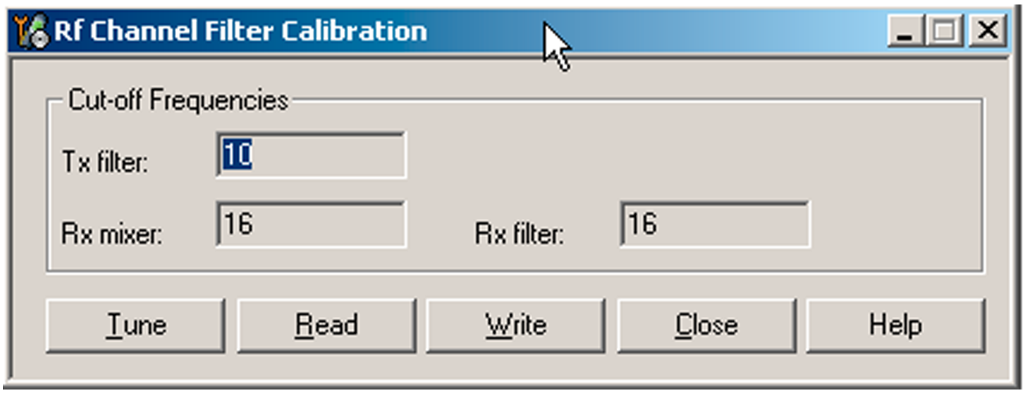
Table 12 Rf channel filter calibration tuning limits

	Min	Typ	Max
Tx filter	0	10	31
RX mixer	0	13	31
Rx filter	0	16	31

Steps

1. From the **Operating mode** drop-down menu, set mode to **Local**.
2. Choose **Tuning→Rf Channel Filter Calibration** .
3. Click **Tune**.
4. To save the values to the PMM (Phone Permanent Memory) area, click **Write**.
5. To close the *Rf Channel Filter Calibration* window, click **Close**.

Results



Tx filter: 10
Rx mixer: 16
Rx filter: 16

Figure 22 Rf channel filter calibration typical values

PA (power amplifier) detection

Context

The PA detection procedure detects which PA manufacturer is used for phone PAs.

If a PA is changed or if the permanent memory (PMM) data is corrupted, PA detection has to be performed before Tx tunings.

Steps

1. From the **Operating mode** drop-down menu, set mode to **Local**.
2. Choose **Tuning→PA Detection** .

3. Click **Tune**.
4. Check that the detected PA manufacturers are corresponding to the actual chips on the board.
5. To end the procedure, click **Close**.

GSM receiver tunings

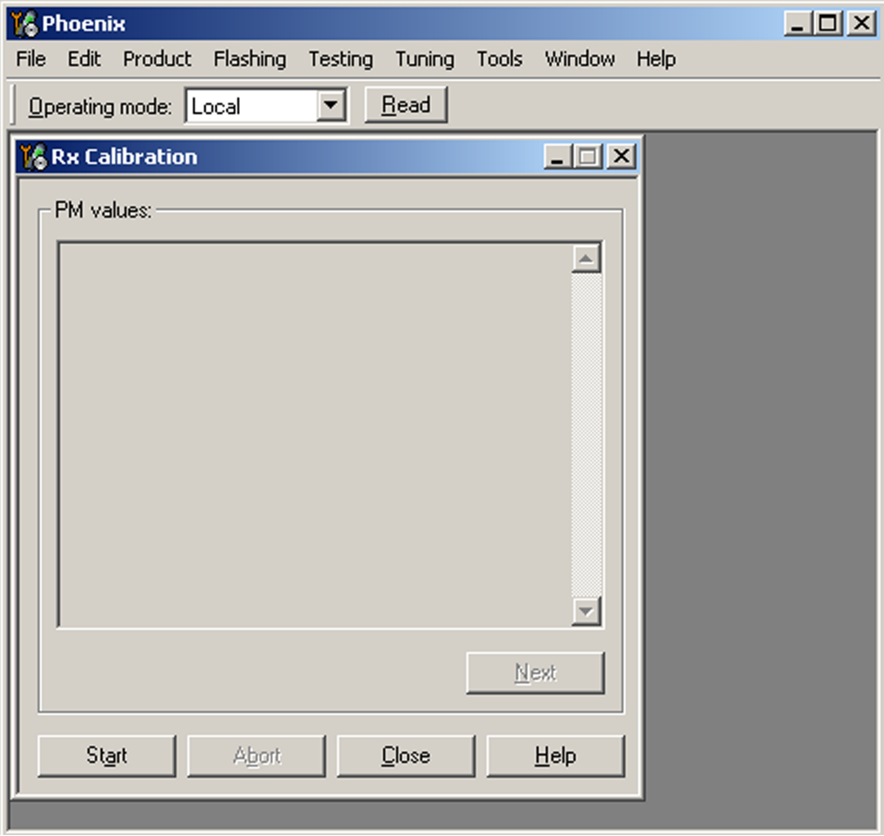
Rx calibration (GSM)

Context

Rx Calibration is used to find out the real gain values of the GSM Rx AGC system and tuning response of the AFC system (AFC D/A init value and AFC slope)

Steps

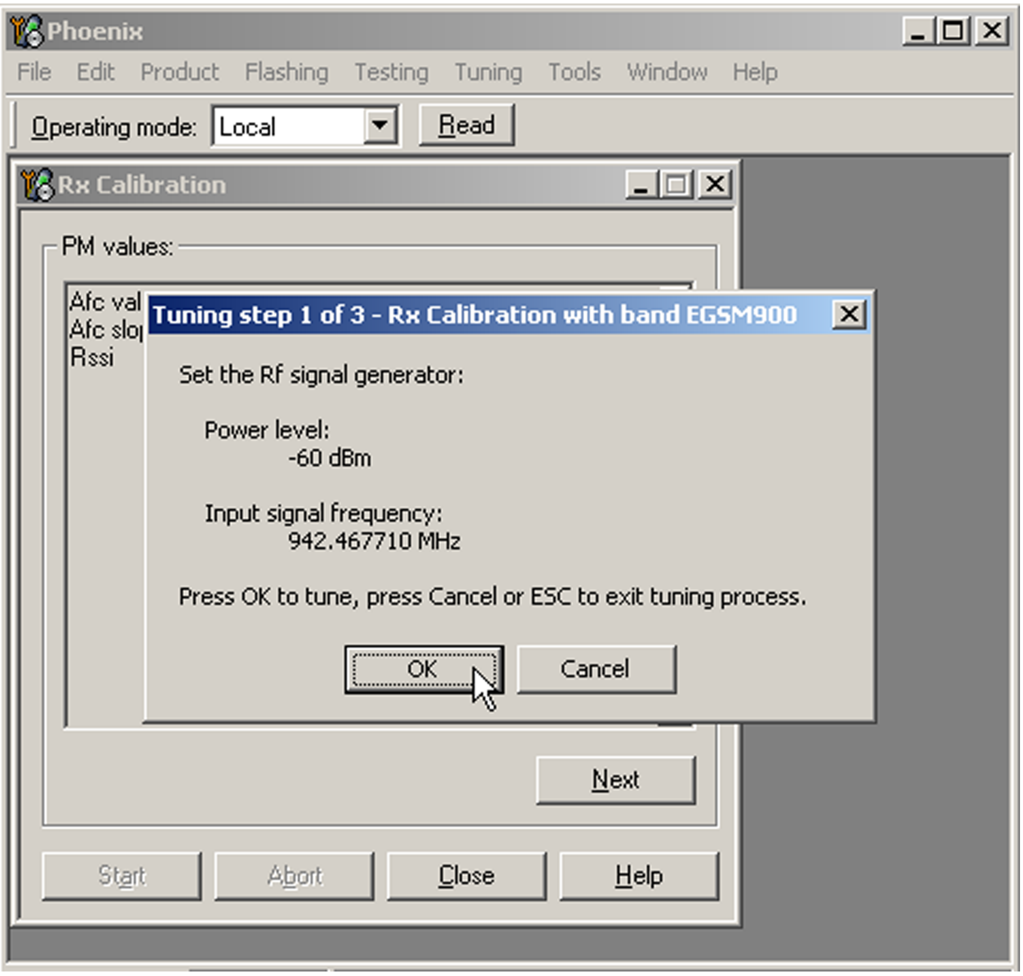
1. Connect the GSM connector of the module jig to a signal generator.
2. Start *Phoenix* service software.
3. From the **Operating mode** drop-down menu, set mode to **Local**.
4. Choose **Tuning→GSM→Rx Calibration** .
5. Click **Start**.


Phoenix
File Edit Product Flashing Testing Tuning Tools Window Help
Read
Rx Calibration
PM values:
Next
Start
Abort
Close
Help

Operating mode: Local

6. Connect the signal generator to the phone, and set frequency and amplitude as instructed in the **Rx Calibration with band EGSM900** (step 1-3) pop-up window.

   Important: The calibration uses a non-modulated CW signal. Increase the signal generator level by cable attenuation and module jig probe attenuation.


Phoenix
File Edit Product Flashing Testing Tuning Tools Window Help
Operating mode: Local
Read
Rx Calibration
PM values:
Afc val
Afc slo
Rssi
Next
Start
Abort
Close
Help

Tuning step 1 of 3 - Rx Calibration with band EGSM900

Set the Rf signal generator:

Power level:
-60 dBm

Input signal frequency:
942.467710 MHz

Press OK to tune, press Cancel or ESC to exit tuning process.

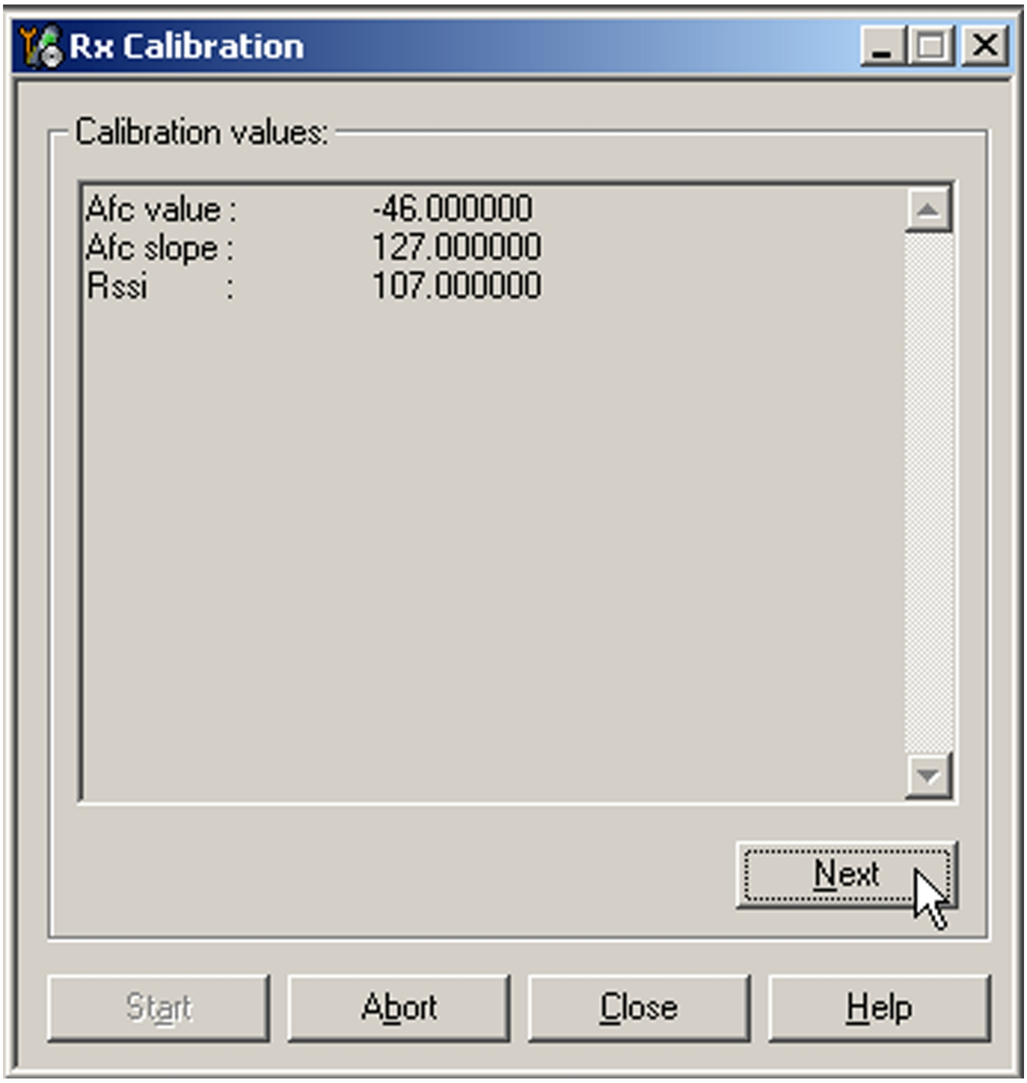
OK
Cancel

7. To perform the tuning, click **OK**.
8. Check that the tuning values are within the limits specified in the following table:

Table 13 RF tuning limits in Rx calibration

	Min	Typ	Max	Unit
GSM850				
AFC Value (init)	-200	-80..40	200	dB
AFC slope	0	108..121	200	dB
RSSI (AGC-0)	106	107..110	114	dB
GSM900				
AFC Value (init)	-200	-105..62	200	dB
AFC slope	0	122	200	dB
RSSI (AGC-0)	106	107...110	114	dB
GSM1800				
RSSI (AGC-0)	105	105...109	114	dB
GSM1900				
RSSI (AGC-0)	105	105...109	114	dB

9. Click **Next** to continue with GSM1800 Rx tuning.



Afc value : -46.000000
Afc slope : 127.000000
Rssi : 107.000000

Next actions

Repeat steps 6 to 9 for GSM1800 and GSM1900

Rx band filter response compensation (GSM)

Prerequisites

Rx calibration must be performed before the Rx band filter response compensation.

Context

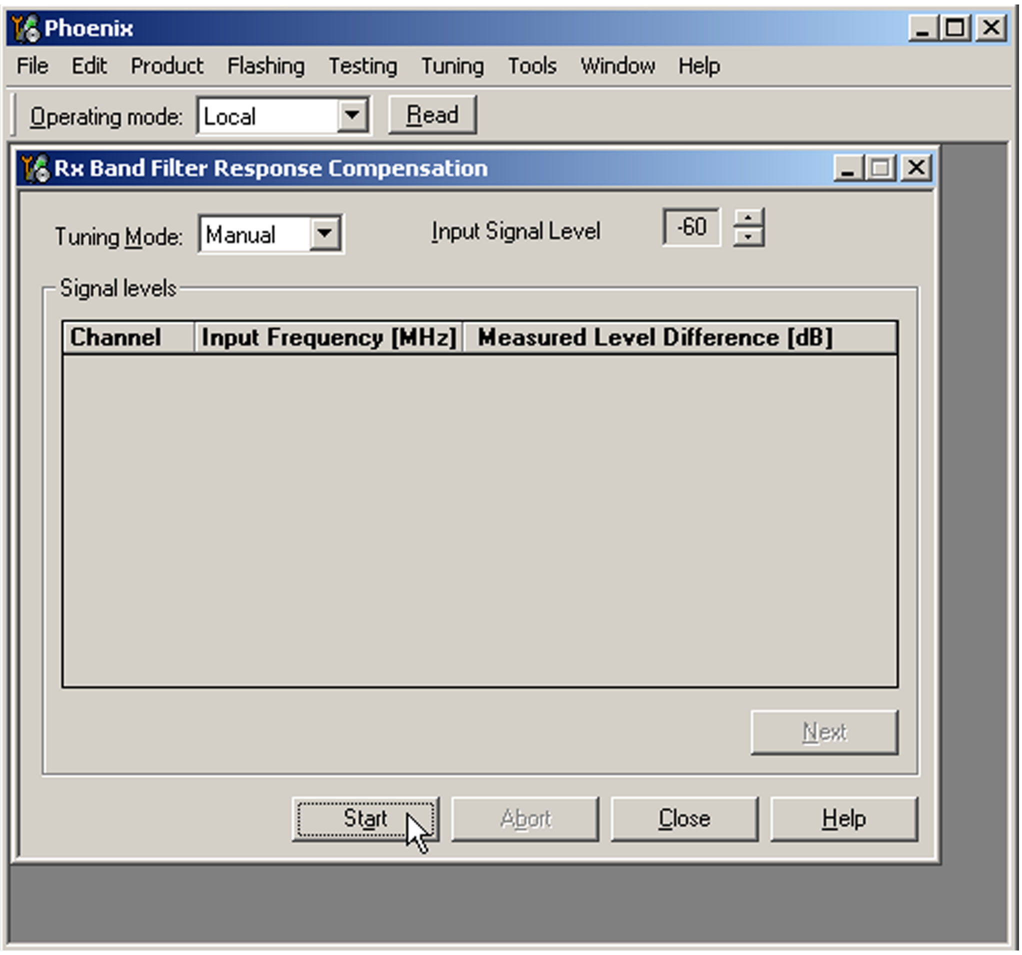
On each GSM Rx band, there is a band filter in front of the RF ASIC front end. The amplitude ripple caused by these filters causes ripple to the RSSI measurement, and therefore calibration is needed.

The calibration has to be repeated for each GSM band.

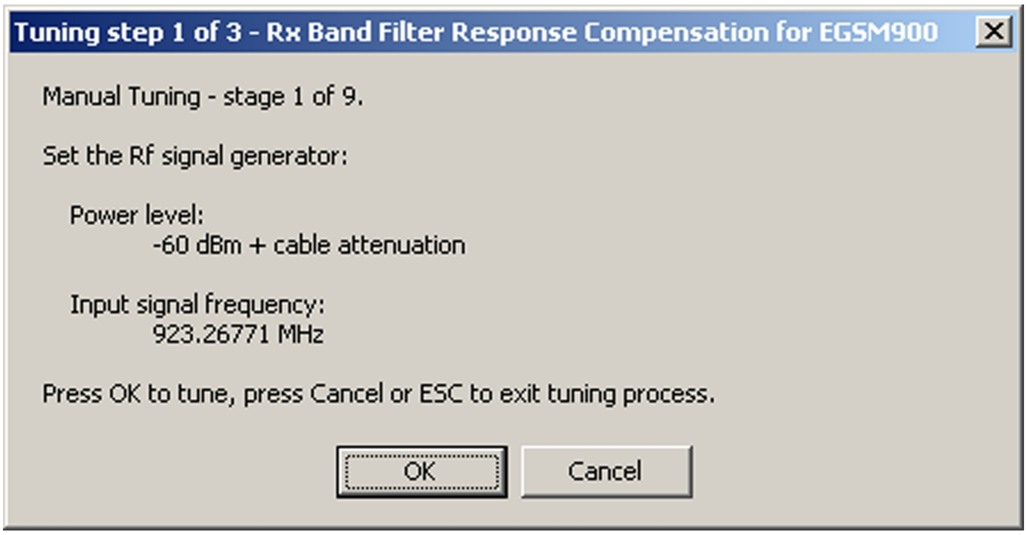
Steps

1. Connect the GSM connector of the module jig to a signal generator.
2. Start *Phoenix* service software.
3. From the **Operating mode** drop-down menu, set mode to **Local**.

4. Choose **Tuning→GSM→Rx Band Filter Response Compensation** .
5. Select **GSM900** band.
6. Select **Tuning mode: manual**
7. Click **Start**.


Phoenix
File Edit Product Flashing Testing Tuning Tools Window Help
Operating mode: Local
Read
Rx Band Filter Response Compensation
Tuning Mode: Manual
Input Signal Level -60
Signal levels
Channel | Input Frequency [MHz] | Measured Level Difference [dB]
Next
Start
Abort
Close
Help

8. Connect the signal generator to the phone, and set frequency and amplitude as instructed in the *Rx Band Filter Response Compensation for EGSM900* pop-up window, step 1-3.


Tuning step 1 of 3 - Rx Band Filter Response Compensation for EGSM900

Manual Tuning - stage 1 of 9.

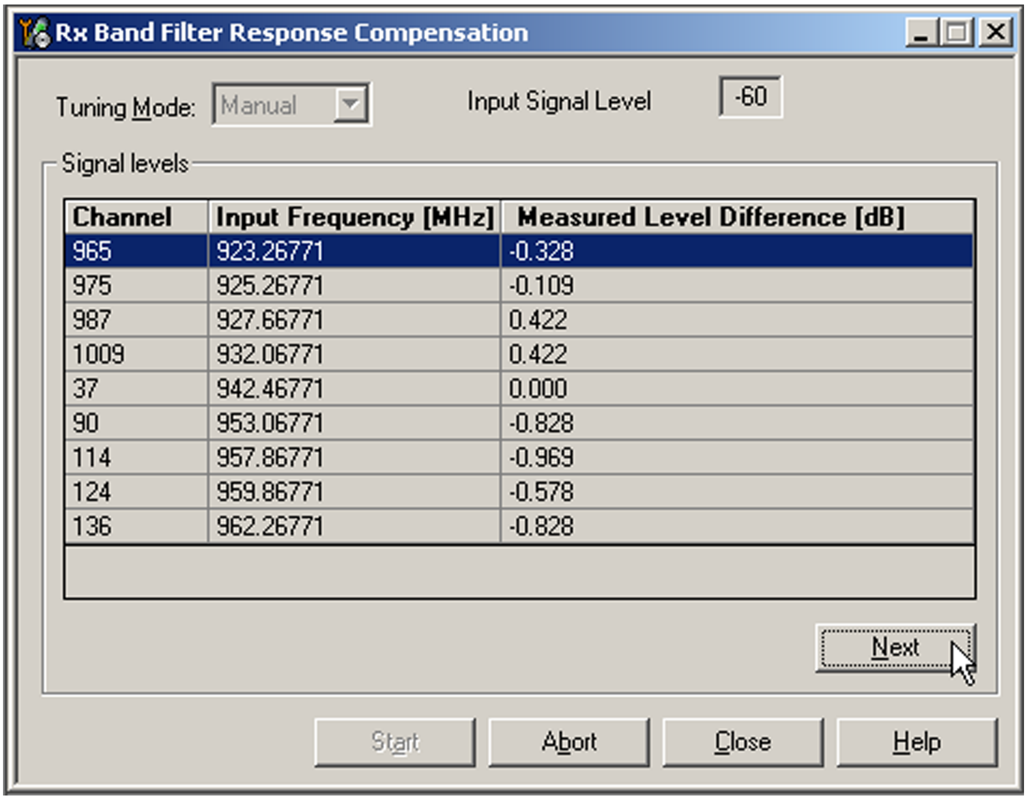
Set the RF signal generator:

Power level:
-60 dBm + cable attenuation

Input signal frequency:
923.26771 MHz

Press OK to tune, press Cancel or ESC to exit tuning process.

9. To perform tuning, click **OK**.
10. Go through all 9 frequencies. The following table will be shown:



Tuning Mode: Manual

Input Signal Level -60

Signal levels

Channel	Input Frequency [MHz]	Measured Level Difference [dB]
965	923.26771	-0.328
975	925.26771	-0.109
987	927.66771	0.422
1009	932.06771	0.422
37	942.46771	0.000
90	953.06771	-0.828
114	957.86771	-0.969
124	959.86771	-0.578
136	962.26771	-0.828

11. Check that the tuning values are within the limits specified in the following table:

	Min	Typ	Max	Unit
GSM850				
Ch. 118/867.26771 MHz	-6	-1	2	dB
Ch. 128/869.26771 MHz	-3	0	2	dB
Ch. 140/871.66771 MHz	-3	0	2	dB
Ch. 172/878.06771 MHz	-3	0	2	dB
Ch. 190/881.66771 MHz	-3	0	2	dB
Ch. 217 / 887.06771 MHz	-3	0	2	dB
Ch. 241/891.86771 MHz	-3	0	2	dB
Ch. 251/893.86771 MHz	-3	0	2	dB
Ch. 261/895.86771 MHz	-6	-1	2	dB
GSM900				
Ch. 965 / 923.26771 MHz	-6	-1	2	dB
Ch. 975 / 925.26771 MHz	-3	0	2	dB
Ch. 987 / 927.66771 MHz	-3	0	2	dB
Ch. 1009 / 932.06771 MHz	-3	0	2	dB

	Min	Typ	Max	Unit
Ch. 37 / 942.46771 MHz	-3	0	2	dB
Ch. 90 / 953.06771 MHz	-3	0	2	dB
Ch. 114 / 957.86771 MHz	-3	0	2	dB
Ch. 124 / 959.86771 MHz	-3	0	2	dB
Ch. 136 / 962.26771 MHz	-6	-1	2	dB
GSM1800				
Ch. 497 / 1802.26771 MHz	-6	-1	3	dB
Ch. 512 / 1805.26771 MHz	-3	0	3	dB
Ch. 535 / 1809.86771 MHz	-3	0	3	dB
Ch. 606 / 1824.06771 MHz	-3	0	3	dB
Ch. 700 / 1842.86771 MHz	-3	0	3	dB
Ch. 791 / 1861.06771 MHz	-3	0	3	dB
Ch. 870 / 1876.86771 MHz	-3	0	3	dB
Ch. 885 / 1879.86771 MHz	-3	0	3	dB
Ch. 908 / 1884.46771 MHz	-6	-1	3	dB
GSM1900				
Ch. 496 / 1927.06771 MHz	-6	-1	3	dB
Ch. 512 / 1930.26771 MHz	-3	0	3	dB
Ch. 537 / 1935.26771 MHz	-3	0	3	dB
Ch. 586 / 1945.06771 MHz	-3	0	3	dB
Ch. 661 / 1960.06771 MHz	-3	0	3	dB
Ch. 736 / 1975.06771 MHz	-3	0	3	dB
Ch. 794 / 1986.66771 MHz	-3	0	3	dB
Ch. 810 / 1989.86771 MHz	-3	0	3	dB
Ch. 835 / 1994.86771 MHz	-6	-1	3	dB

12. If the values are within the limits, click **Next** to continue to the next band.

Next actions

Repeat the steps 8 to 12 for GSM1800 and GSM1900.

■ GSM transmitter tunings

Tx IQ tuning (GSM)

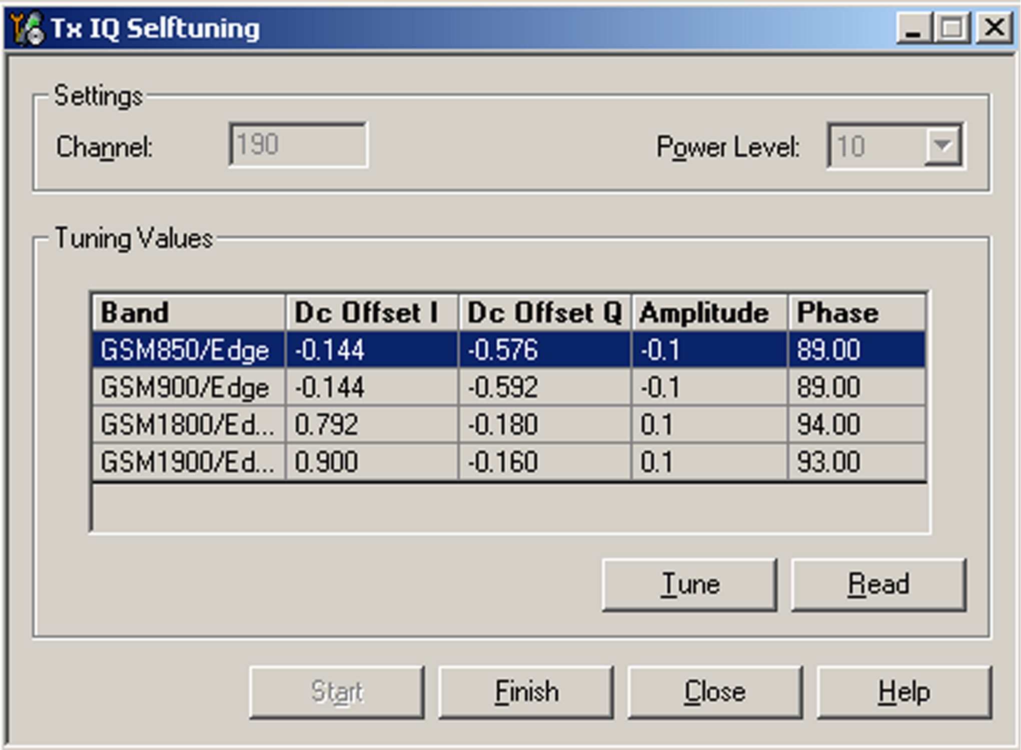
Context

The Tx path branches to I and Q signals at RF I/Q modulator. Modulator and analog hardware located after it cause unequal amplitude and phase disturbance to I and Q signal paths. Tx IQ tuning balances the I and Q branches.

Tx IQ tuning must be performed for all GSM bands.

Steps

1. Start *Phoenix* service software.
2. From the **Operating mode** drop-down menu, set mode to **Local**.
3. Choose **Tuning→GSM→Tx IQ Tuning** .
4. Press**Start**.



Channel: 190

Power Level: 10

Band	Dc Offset I	Dc Offset Q	Amplitude	Phase
GSM850/Edge	-0.144	-0.576	-0.1	89.00
GSM900/Edge	-0.144	-0.592	-0.1	89.00
GSM1800/Ed...	0.792	-0.180	0.1	94.00
GSM1900/Ed...	0.900	-0.160	0.1	93.00

5. Tap the option**Tune all**.
6. Press **Tune**.
7. Click **Close** to finish the TX IQ tuning.
8. Click**Finish** and then **Close**.

Next actions

Tuning sliders should be close to the center of the scale after the tuning and within the limits specified in the following table. If they are not within the limits, check Tx IQ quality manually.

	Min	Typ	Max	Unit
GSM850				
I DC offset / Q DC offset	-6	-4	6	%
Ampl	-1	0	1	dB
Phase	85	90	95	°
GSM900				

	Min	Typ	Max	Unit
I DC offset / Q DC offset	-6	-4	6	%
Ampl	-1	0	1	dB
Phase	85	90	95	°
GSM1800/GSM1900				
I/Q DC	-6	0.5	6	%
Ampl	-1	0	1	dB
Phase	82	90	105	°

Tx power level tuning (GSM)

Context

Because of variations at the IC (Integrated Circuit) process and discrete component values, the actual transmitter RF gain of each phone is different. Tx power level tuning is used to find out mapping factors called 'power coefficients’. These adjust the GSM transmitter output power to fulfill the specifications.

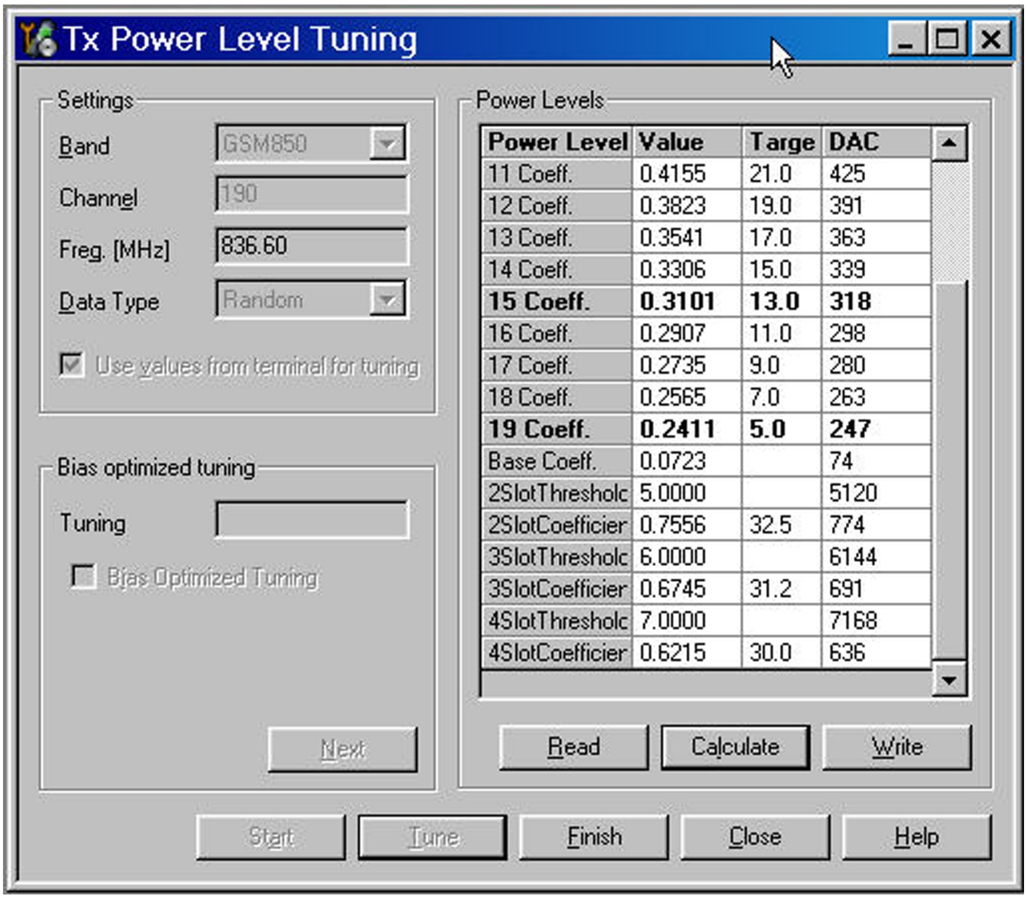
For EDGE transmission, the bias settings of the GSM PA are adjusted in order to improve linearity. This affects the PA gain and hence the power levels have to be aligned separately for EDGE transmission.

Tx power level tuning has to be performed on all GSM bands.

Steps

1. Connect the phone to a spectrum analyzer.
2. Start *Phoenix* service software.
3. From the **Operating mode** drop-down menu, set mode to **Local**.
4. Choose **Tuning→GSM→Tx Power Level Tuning** .

5. Click **Start**.l


Tx Power Level Tuning
Settings
Bias optimized tuning
Power Levels
Next
Read
Calculate
Write
Start
Tune
Finish
Close
Help

Band: GSM850
Channel: 190
Freq. [MHz]: 836.60
Data Type: Random
☑ Use values from terminal for tuning
Tuning:
☐ Bias Optimized Tuning

Power Level	Value	Targe	DAC
11 Coeff.	0.4155	21.0	425
12 Coeff.	0.3823	19.0	391
13 Coeff.	0.3541	17.0	363
14 Coeff.	0.3306	15.0	339
15 Coeff.	**0.3101**	**13.0**	**318**
16 Coeff.	0.2907	11.0	298
17 Coeff.	0.2735	9.0	280
18 Coeff.	0.2565	7.0	263
19 Coeff.	**0.2411**	**5.0**	**247**
Base Coeff.	0.0723		74
2SlotThresholc	5.0000		5120
2SlotCoefficier	0.7556	32.5	774
3SlotThresholc	6.0000		6144
3SlotCoefficier	0.6745	31.2	691
4SlotThresholc	7.0000		7168
4SlotCoefficier	0.6215	30.0	636

6. Set the spectrum analyzer for power level tuning:

Frequency	Channel frequency: • **836.6 MHz GSM850** • **897.4MHz GSM900** • **1747.8MHz GSM1800** • **1880MHz GSM1900**
Span	0 Hz
Sweep time	2ms
Trigger	Video triggering (-10dBm)
Resolution BW	3MHz
Video BW	3MHz
Reference level offset	sum cable attenuation with module jig attenuation
Reference level	33dBm

A power meter with a peak power detector can be also used. Remember to take the attenuations into account.

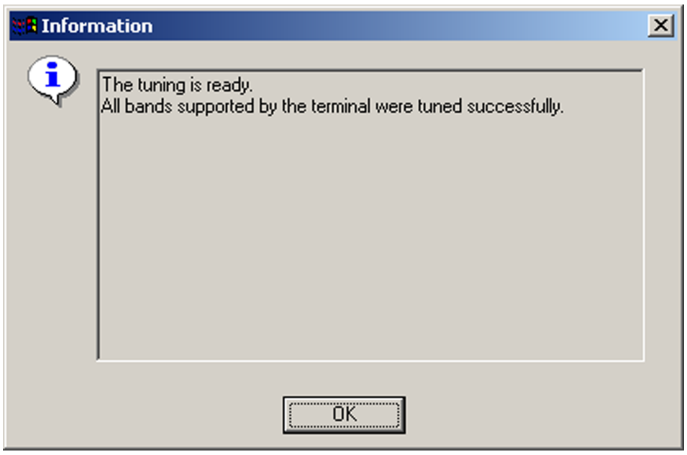
7. Set the tuning targets according to the values in the table below

GMSK	1 slot	2slot	3 slot
850	32,5	32	30,5
900	32,5	31	29
1800	29,5	29,5	28,2
1900	29,5	29	27
EDGE	1 slot	2slot	3 slot
850	26,5	26,5	25,2
900	26,5	26,5	25,2
1800	25	25	24,2
1900	25	25	24,2
WCDMA band I	23,5		
WCDMA band II	23,5		
WCDMA band V	23,5		
WCDMA band VIII	23,5		

8. Adjust power for all bold power levels to correspond the **Target dBm** column by pressing **+** or **–** keys.
9. If all bold power levels are adjusted, click **Next** to continue with **GSM850 EDGE**.
10. Adjust power for all bold power levels to correspond the **Target dBm** column by pressing **+** or **–** keys.

Next actions

Continue tuning the bold power levels of the GSM900, GSM1800 and GSM1900 bands. You will see this message, if finished successfully:



The tuning is ready.
All bands supported by the terminal were tuned successfully.

WCDMA receiver tunings

RX calibration (WCDMA)

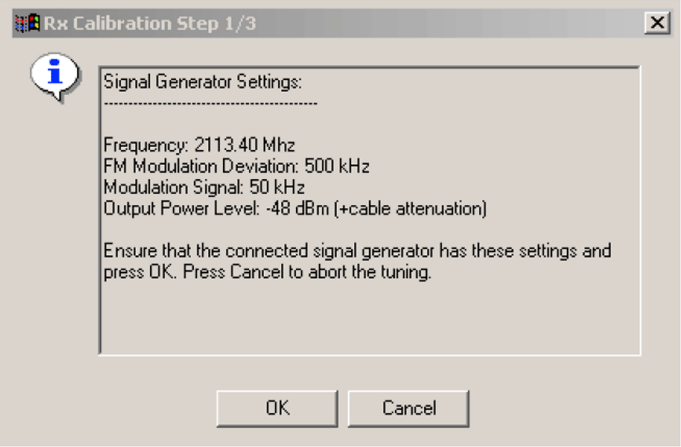
Context

Rx calibration tuning routine calculates the real gain values of the WCDMA Rx AGC system. There is also a SAW filter between front end LNA and mixer in the receive chain, which causes ripple in the RSSI measurement, this is calibrated out. The SAW filter is intergated into RF ASIC N7505.

Rx calibration can be done in two different ways, manual tune and sweep mode tune. If the signal generator in use supports frequency sweep table, the calibration is done in one step.

Steps

1. For manual tuning, set mode to **Local** in the **Operating Mode** dropdown menu.
2. In the **Tuning** menu, choose **WCDMA→Rx Calibration** .
3. Click **Start**.
4. Select Band "WCDMA 2100".
5. Click **Tune**.
6. Setup the signal generator to correspond with the values on the, *Rx Calibration* pop-up window and click **OK**.



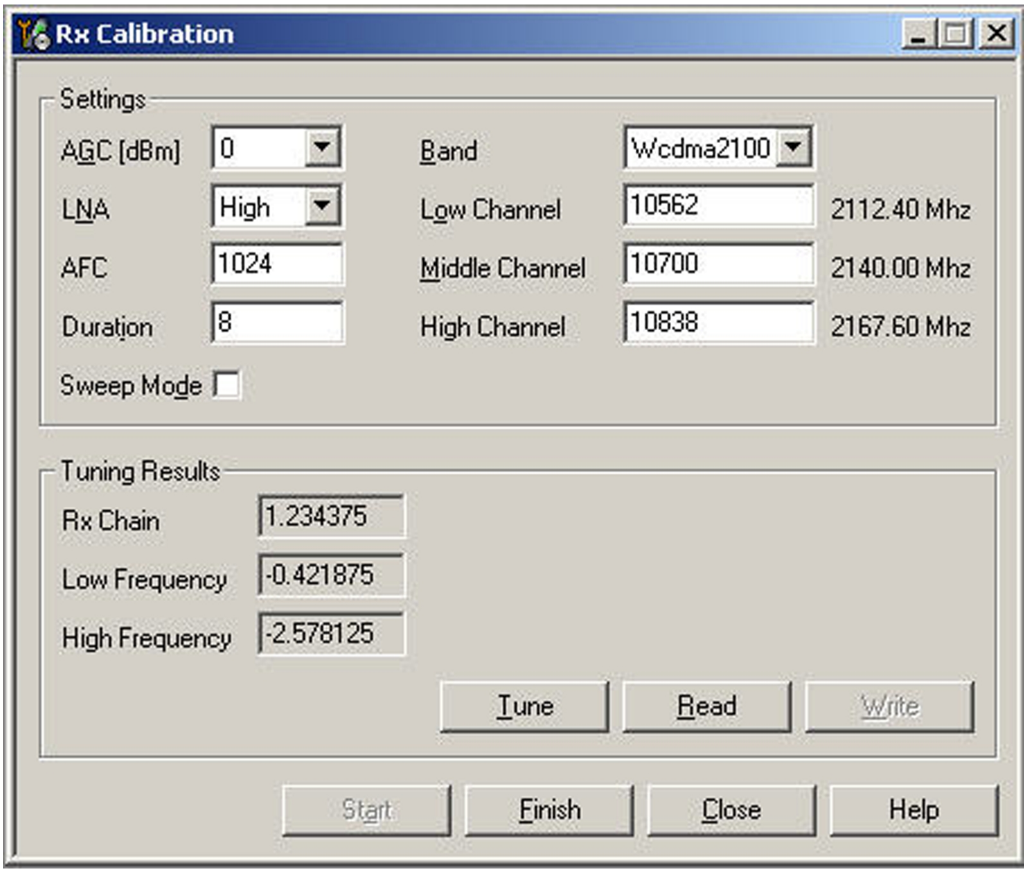
Signal Generator Settings:

Frequency: 2113.40 Mhz
FM Modulation Deviation: 500 kHz
Modulation Signal: 50 kHz
Output Power Level: -48 dBm (+cable attenuation)

Ensure that the connected signal generator has these settings and press OK. Press Cancel to abort the tuning.

Figure 23 Pop-up window for WCDMA2100

7. Repeat step 6. for Middle and High channels.



Settings

AGC [dBm] 0

LNA High

AFC 1024

Duration 8

Sweep Mode ☐

Band Wcdma2100

Low Channel 10562 2112.40 Mhz

Middle Channel 10700 2140.00 Mhz

High Channel 10838 2167.60 Mhz

Tuning Results

Rx Chain 1.234375

Low Frequency -0.421875

High Frequency -2.578125

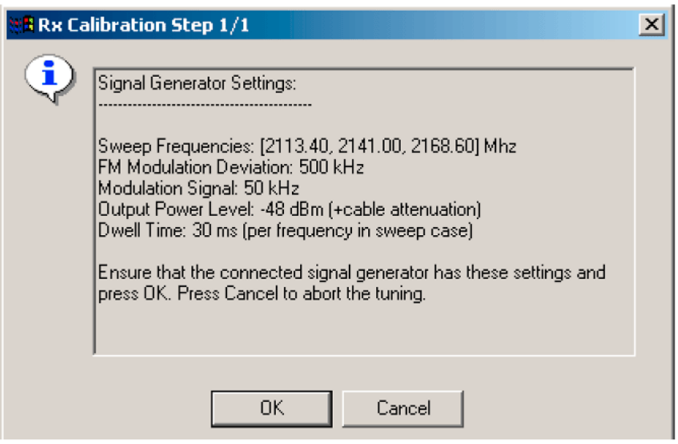
8. Ensure Tuning Results are within limits specified in the table below:
   If values are OK, click **Write** to save the values.

	Band	Min	Typ	Max	Unit
Rx chain	2100	-6	1.5 to 3.5	6	dB
Low Frequency		-5	-0.7 to 4.0	5	
High Frequency		-5	-0.7 to 4.0	5	

Alternative steps

- For sweep mode tuning, set **Mode** to **Local** in the **Operating Mode** dropdown menu.
- In the **Tuning** menu, choose **WCDMA**→ **Rx Calibration** .
- Click **Start**.
- Select **Band**, "WCDAM2100".
- Check the **Sweep Mode** box.
- Click **Tune**.

- Setup the signal generator to correspond with the values on the *Rx Calibration* pop-up window and click **OK**.



Signal Generator Settings:

Sweep Frequencies: [2113.40, 2141.00, 2168.60] Mhz
FM Modulation Deviation: 500 kHz
Modulation Signal: 50 kHz
Output Power Level: -48 dBm (+cable attenuation)
Dwell Time: 30 ms (per frequency in sweep case)

Ensure that the connected signal generator has these settings and press OK. Press Cancel to abort the tuning.

Figure 24 Pop-up window for WCDMA2100

- Ensure Tuning Results are within limits specified in the table above: If values are OK, click **Write** to save the values to the phone.
- Close the tuning window.

WCDMA transmitter tunings

Tx AGC & power detector (WCDMA)

Context

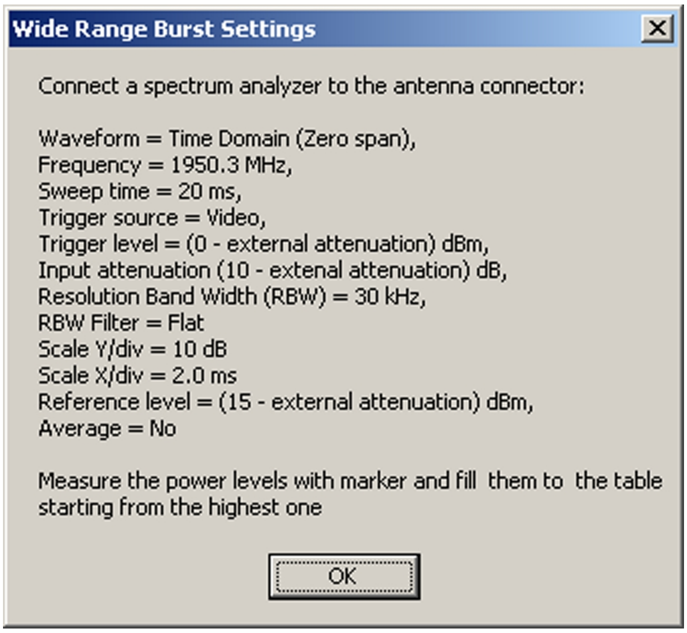
Tx AGC & power detector tuning has two purposes:

- to enable the phone to select the correct TxC value accurately in order to produce the required RF level
- to enable the phone to measure its own transmitter power accurately

Steps

1. From the **Operating mode** drop-down menu, set mode to **Local**.
2. Choose **Tuning→WCDMA→Tx AGC & Power Detector.**
3. Click **Start**.
4. In the *Wide Range* pane, click **Tune** (the leftmost **Tune** button).

5. Set up the spectrum analyzer in the following way:



Connect a spectrum analyzer to the antenna connector:

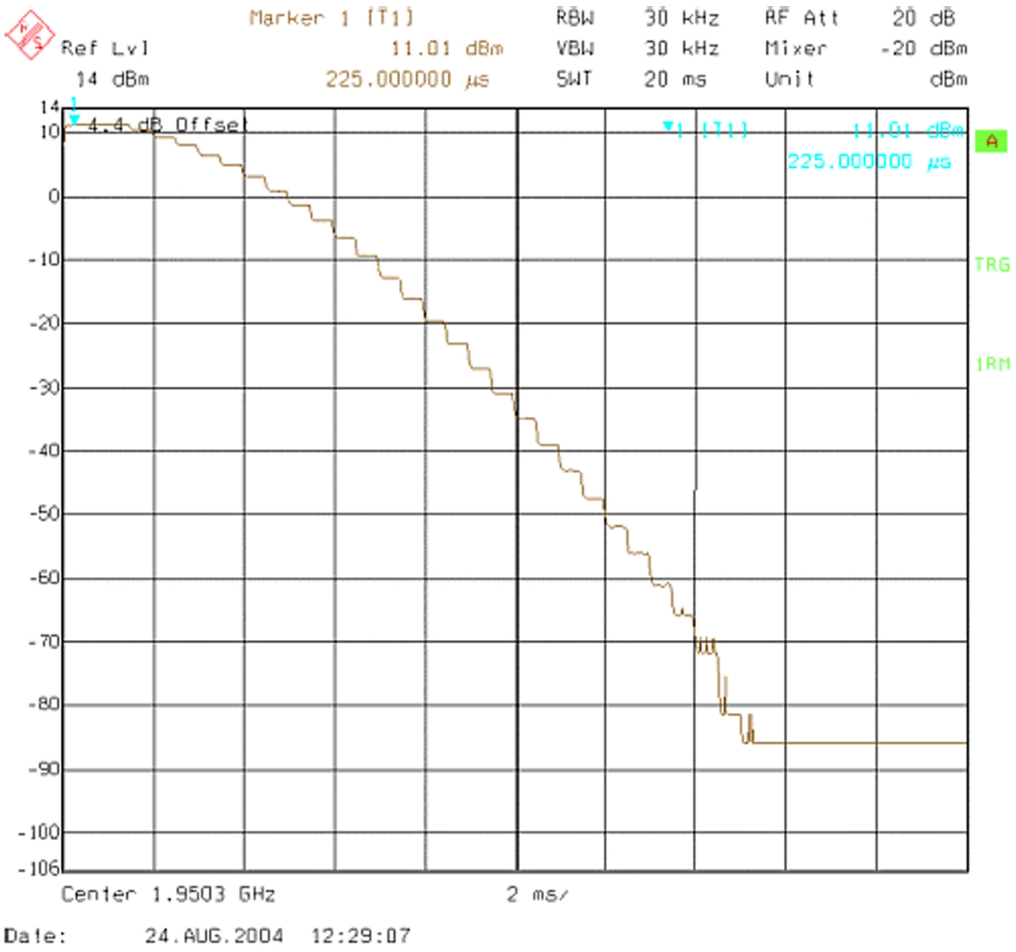
Waveform = Time Domain (Zero span),
Frequency = 1950.3 MHz,
Sweep time = 20 ms,
Trigger source = Video,
Trigger level = (0 - external attenuation) dBm,
Input attenuation (10 - extenal attenuation) dB,
Resolution Band Width (RBW) = 30 kHz,
RBW Filter = Flat
Scale Y/div = 10 dB
Scale X/div = 2.0 ms
Reference level = (15 - external attenuation) dBm,
Average = No

Measure the power levels with marker and fill them to the table starting from the highest one

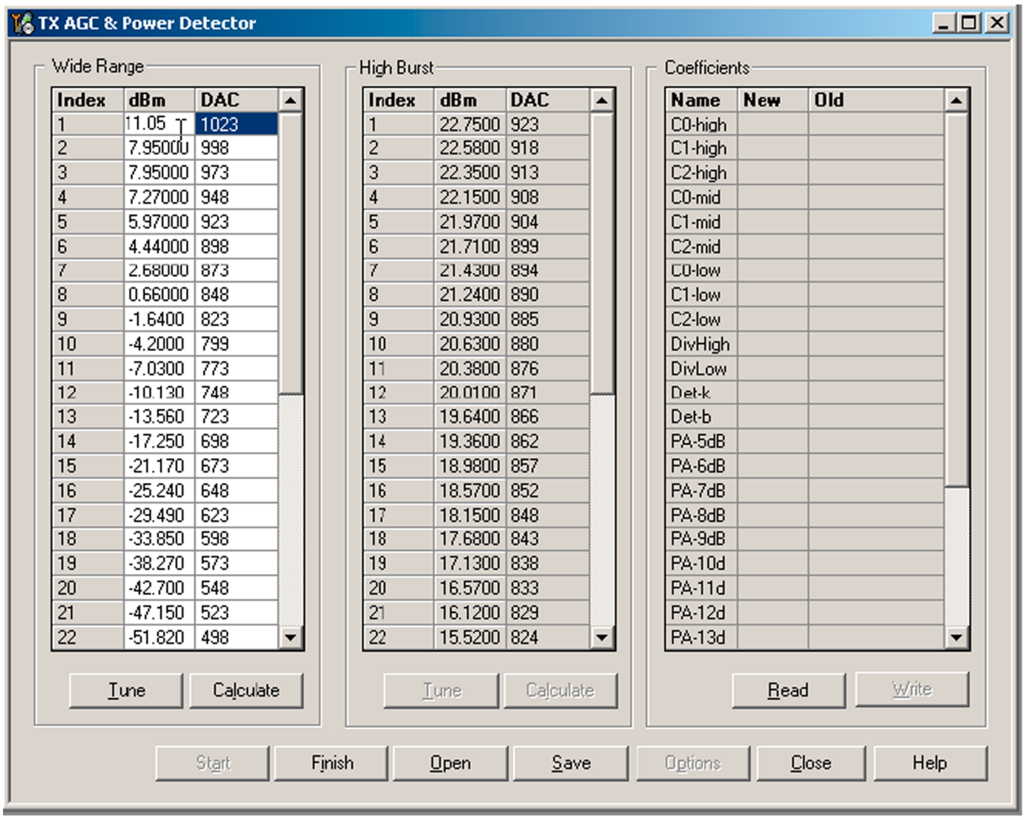
6. After setting the spectrum analyzer, click **OK**.
7. Measure the power levels with a marker.

   Take the first measurement from 250 us after the trigger, the second after 750 us, the third after 1250 us and so on for every 500 us until the table is filled.

   > **Note:** It must be possible to measure power levels down to –68 dBm. The measured power levels must be monotonously decreasing.
   >
   > Make sure that the marker is not measuring the level of noise spikes on lower levels.


Marker 1 [T1]
11.01 dBm
225.000000 µs
Ref Lvl
14 dBm
RBW 30 kHz
VBW 30 kHz
SWT 20 ms
RF Att 20 dB
Mixer -20 dBm
Unit dBm
4.4 dB Offset
▼1 [T1] 11.01 dBm
225.000000 µs
A
TRG
1RM
14
10
0
-10
-20
-30
-40
-50
-60
-70
-80
-90
-100
-106
Center 1.9503 GHz
2 ms/
Date: 24.AUG.2004 12:29:07

8. Fill in the power level values (in dBm) to the *Wide Range* table.



Wide Range

Index	dBm	DAC
1	11.05	1023
2	7.95000	998
3	7.95000	973
4	7.27000	948
5	5.97000	923
6	4.44000	898
7	2.68000	873
8	0.66000	848
9	-1.6400	823
10	-4.2000	799
11	-7.0300	773
12	-10.130	748
13	-13.560	723
14	-17.250	698
15	-21.170	673
16	-25.240	648
17	-29.490	623
18	-33.850	598
19	-38.270	573
20	-42.700	548
21	-47.150	523
22	-51.820	498

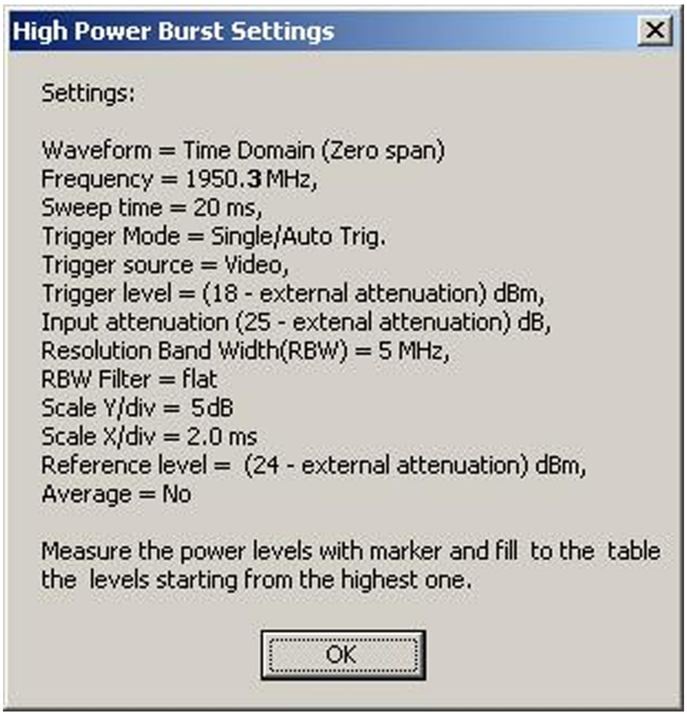
High Burst

Index	dBm	DAC
1	22.7500	923
2	22.5800	918
3	22.3500	913
4	22.1500	908
5	21.9700	904
6	21.7100	899
7	21.4300	894
8	21.2400	890
9	20.9300	885
10	20.6300	880
11	20.3800	876
12	20.0100	871
13	19.6400	866
14	19.3600	862
15	18.9800	857
16	18.5700	852
17	18.1500	848
18	17.6800	843
19	17.1300	838
20	16.5700	833
21	16.1200	829
22	15.5200	824

Coefficients

Name	New	Old
C0-high		
C1-high		
C2-high		
C0-mid		
C1-mid		
C2-mid		
C0-low		
C1-low		
C2-low		
DivHigh		
DivLow		
Det-k		
Det-b		
PA-5dB		
PA-6dB		
PA-7dB		
PA-8dB		
PA-9dB		
PA-10d		
PA-11d		
PA-12d		
PA-13d		

9. In the *Wide Range* pane, click **Calculate**.
10. In the *High Burst* pane, click **Tune**.
11. Adjust the spectrum analyzer according to the following settings (in addition depending on spectrum analyzer use 30 kHz video bandwidth):



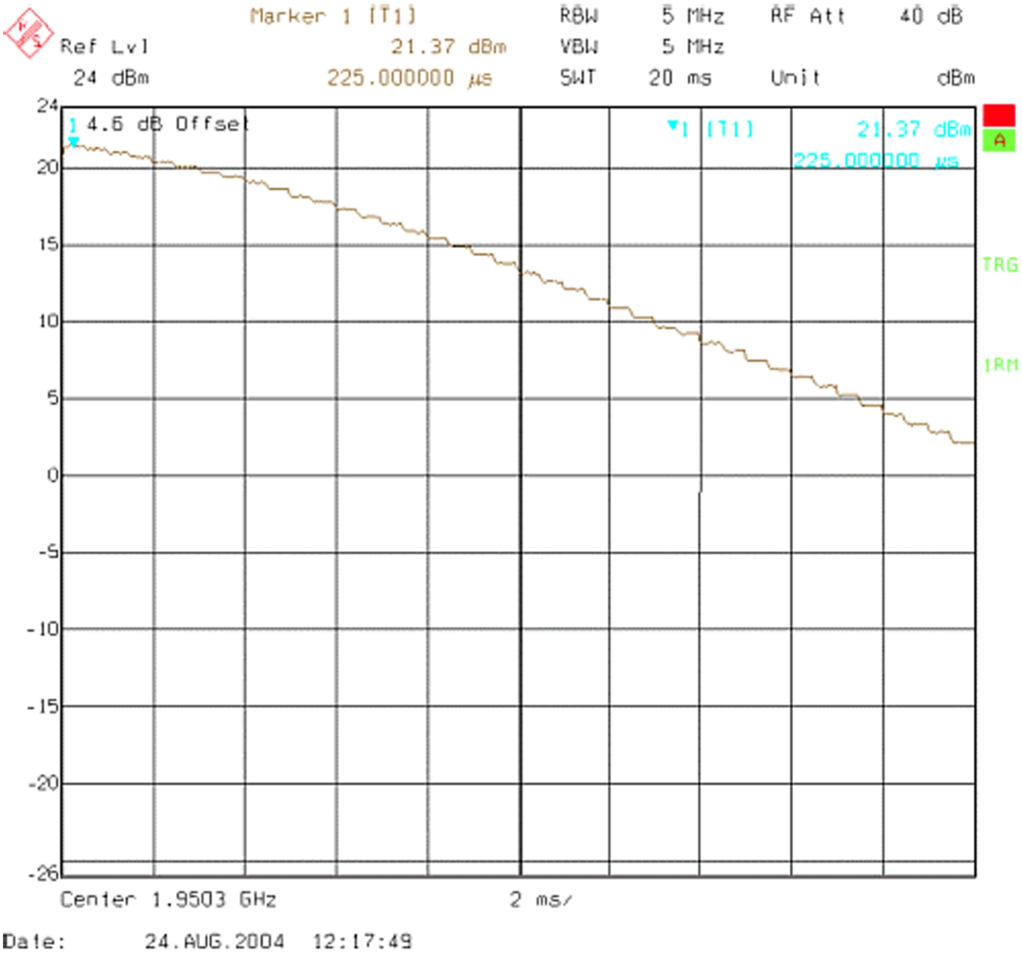
Settings:

Waveform = Time Domain (Zero span)
Frequency = 1950.3 MHz,
Sweep time = 20 ms,
Trigger Mode = Single/Auto Trig.
Trigger source = Video,
Trigger level = (18 - external attenuation) dBm,
Input attenuation (25 - extenal attenuation) dB,
Resolution Band Width(RBW) = 5 MHz,
RBW Filter = flat
Scale Y/div = 5dB
Scale X/div = 2.0 ms
Reference level = (24 - external attenuation) dBm,
Average = No

Measure the power levels with marker and fill to the table the levels starting from the highest one.

12. Measure the power levels with a marker.

    Take the first measurement from 250 us after the trigger, the second after 750 us, the third after 1250 us and so on for every 500 us until the table is filled.



Marker 1 [T1] 21.37 dBm 225.000000 µs
RBW 5 MHz
VBW 5 MHz
SWT 20 ms
RF Att 40 dB
Unit dBm
Ref Lvl 24 dBm
1 4.6 dB Offset
Center 1.9503 GHz
2 ms/
Date: 24.AUG.2004 12:17:49

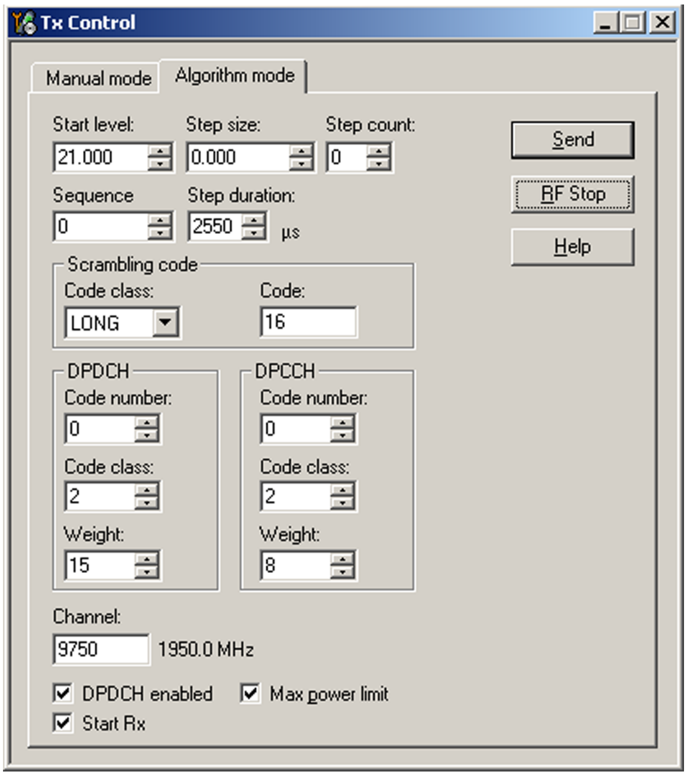
Figure 25 High burst measurement

13. In the *High Burst* pane, click **Calculate**.
14. Check that the calculated values are within the limits specified in the following table:

	Min	Max
C0-high	-0.5	5
C1-high	-50	50
C2-high	400	900
C0-mid	-0.7	0.7
C1-mid	0	50
C2-mid	400	900
C0-low	-4	4
C1-low	-400	440
C2-low	-10000	15000

	Min	Max
Det-k	100	220
Det-b	0	150

15. To save the coefficients to the phone, click **Write**.
16. To close the *Tx AGC & Power Detector* window, click **Close**.
17. Choose **Testing→WCDMA→ Tx Control.**
18. Select the *Algorithm* mode tab.



Start level: 21.000
Step size: 0.000
Step count: 0
Sequence: 0
Step duration: 2550 µs

Scrambling code
Code class: LONG
Code: 16

DPDCH
Code number: 0
Code class: 2
Weight: 15

DPCCH
Code number: 0
Code class: 2
Weight: 8

Channel: 9750 1950.0 MHz

☑ DPDCH enabled ☑ Max power limit
☑ Start Rx

19. Write the target power level 25 dBm to the *Start level* line and check the **Max power limit** check box (detector calibration check). Write "1" to Sequence box.
20. Setup the spectrum analyzer with the following settings:

Center frequency	1950.0 MHz
Span	0 Hz
Reference level offset	Cable attenuations + adapter attenuation
Reference level	28 dBm or -20 dBm depending on the level measured
Input attenuation	Automatic
Resolution bandwidth	5 MHz
Video bandwidth	5 MHz (depending on spectrum analyzer use 30 kHz VBW)
Sweep time	5 ms

Detector	RMS detector
Average	No
Trigger level	Video 0 dBm or -45 dBm

21. Click **Send**.
22. Measure the WCDMA output power. It should be around 23.5 dBm for band I or 23.5 dBm for band II, 23.5 dBm for bands V or VIII.
23. Click **RF Stop** and uncheck the **Max power limit** check box.
24. Repeat steps **19** to **23** for levels +19, +7, 0, -20 and –40 dBm.

    The measured output power may not differ more than +-2 dB from the requested value at level +19 dBm and no more than +-4 dB on lower levels.

    Remember to stop the RF before sending new data.

Tx band response calibration (WCDMA)

Context

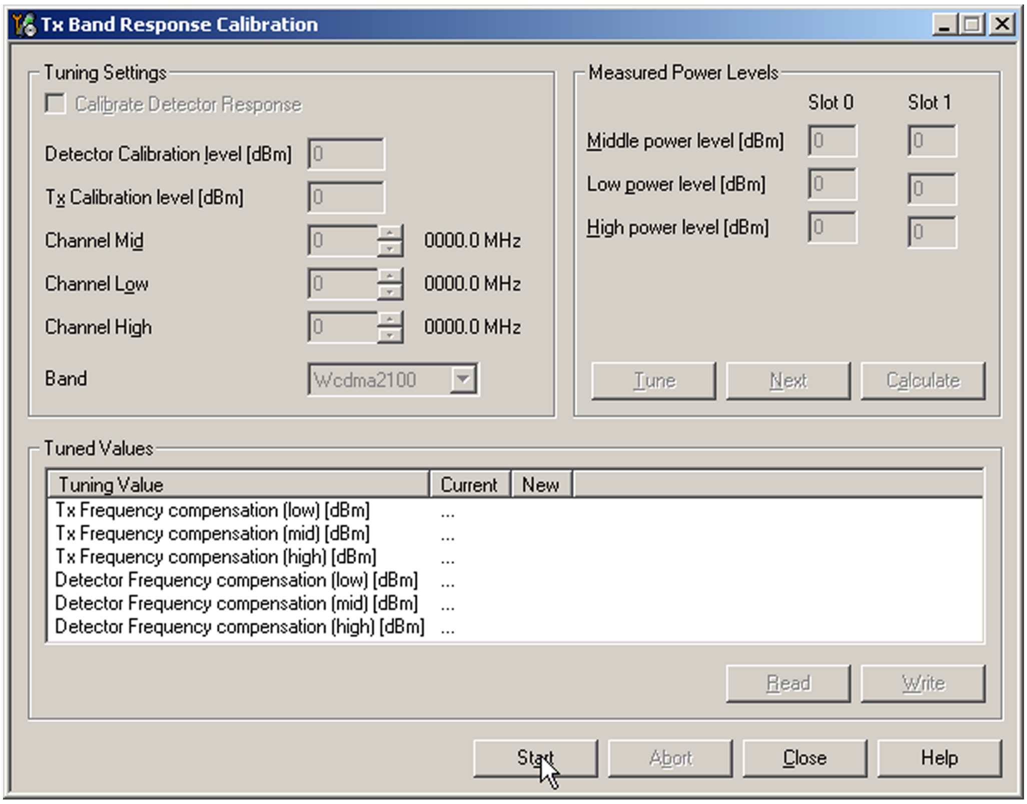
The purpose of this tuning operation is to calibrate the WCDMA Tx performance. It defines the power detector and Tx frequency compensation values. However, before starting this tuning procedure, it is necessary to carry out Tx AGC & Power Detector Calibration tuning. This is because its results will be needed for this tuning operation.

- In the *Tuning Settings* pane, it is possible to edit the numbers of channels used in this tuning operation.
- If the **Calibrate Detector Response** check box is checked, only Tx response is calibrated. Zero is written to the power detector compensation values block in the permanent memory (PM) of the terminal.
- **Detector Calibration level** shows the power level used for calibrating the power detector in this tuning procedure.
- **Tx Calibration level** shows the power level used for calibrating tx frequency in this tuning procedure.
- In the *Measured Power Levels* pane, you can insert the dBm values read from the power meter.
- In the *Tuned Values* pane, the values that are stored in the permanent memory (PM) of the terminal in Current columns are shown.
- New values are added to *New* column when the **Calculate** button is clicked.
- The **Abort** button aborts the tuning operation without saving the tuned values.
- The **Read** button reads the tuned values in the PM of the terminal, and displays them in the *Tuned Values* pane in in the *Current* column.

Steps

1. Start *Phoenix* service software.
2. Choose **File→Scan Product** .
3. From the **Operating mode** drop-down menu, set mode to **Local**.
4. Choose **Tuning→WCDMA→Tx Band Response Calibration** .

5. Click **Start**.



Tx Band Response Calibration

Tuning Settings

☐ Calibrate Detector Response

Detector Calibration level [dBm] 0

Tx Calibration level [dBm] 0

Channel Mid 0 0000.0 MHz

Channel Low 0 0000.0 MHz

Channel High 0 0000.0 MHz

Band Wcdma2100

Measured Power Levels

	Slot 0	Slot 1
Middle power level [dBm]	0	0
Low power level [dBm]	0	0
High power level [dBm]	0	0

Tuned Values

Tuning Value	Current	New
Tx Frequency compensation (low) [dBm]	...	
Tx Frequency compensation (mid) [dBm]	...	
Tx Frequency compensation (high) [dBm]	...	
Detector Frequency compensation (low) [dBm]	...	
Detector Frequency compensation (mid) [dBm]	...	
Detector Frequency compensation (high) [dBm]	...	

The current values are shown in the *Tuned Values* pane.

6. Click **Tune**.
7. Connect the power meter to the terminal, and set it to **Channel Mid** frequency.
8. Read the values of slot 0 and slot 1 from the power meter and enter them to **Middle power level** fields in the **Measured Power Levels** pane.

   Slot 0 is used for detector calibration and slot 1 for Tx calibration.
9. Click **Next**.
10. Switch the power meter to **Channel Low** frequency.
11. Read the values from the power meter, and enter them to **Low power level** fields.
12. Switch the power meter to **Channel High** frequency.
13. Read the values from the power meter, and enter them to **High power level** fields.
14. Click **Next**.
15. Click **Calculate**.

    The tuned values are shown in the *Tuned Values* pane in the *New* column.
16. Check that the tuned values are within the limits presented in the following table. If they are OK, click **Yes**.

	Min	Max
Tx Freq Comp (the first and last value)	-4	+4

17. To save the tuned values to the terminal, click **Write**.

18. Close the *Tx Band Response Calibration* window.

Tx LO leakage (WCDMA)

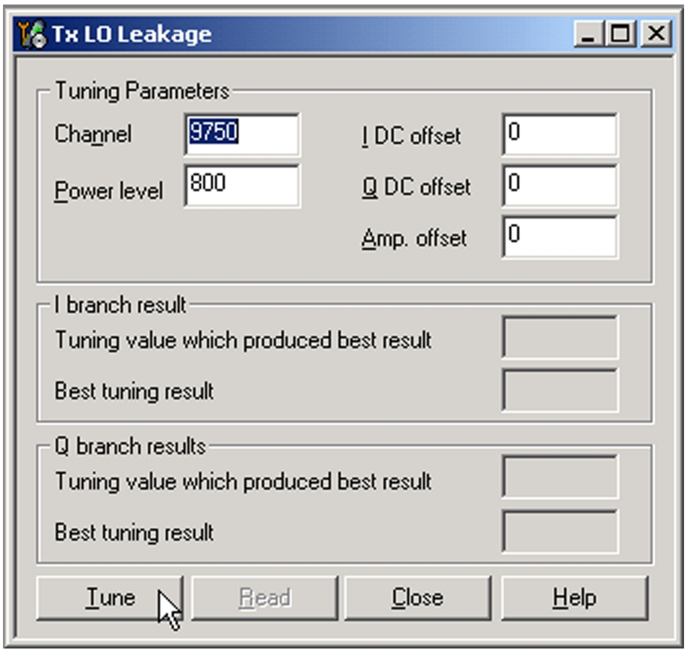
Context

The purpose of Tx LO leakage tuning is to minimize the carrier leakage of the IQ-modulator which is caused by the DC offset voltages in the Tx IQ-signal lines and in the actual IQ modulator.

The tuning improves WCDMA Tx AGC dynamics at low power levels. A self-calibration routine selects the best combination for internal control words in order to produce minimum LO leakage.

Steps

1. From the **Operating mode** drop-down menu, set mode to **Local**.
2. Choose **Tuning→WCDMA→ Tx LO Leakage** .
3. Click **Tune**.


Tx LO Leakage
Tuning Parameters
I branch result
Tuning value which produced best result
Best tuning result
Q branch results
Tuning value which produced best result
Best tuning result
Tune
Read
Close
Help

Channel 9750
Power level 800
I DC offset 0
Q DC offset 0
Amp. offset 0

4. To end the tuning, click **Close**.

5 — Camera Module Troubleshooting

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Introduction to camera module troubleshooting

Background, tools and terminology

Faults or complaints in camera operation can be roughly categorised into three subgroups:

1. Camera is not functional at all; no image can be taken.
2. Images can be taken but there is nothing recognizable in them.
3. Images can be taken and they are recognizable but for some reason the quality of images is seriously degraded.

Image quality is very hard to measure quantitatively, and even comparative measurements are difficult (comparing two images) to do, if the difference is small. Especially if the user is not satisfied with his/her device's image quality, and tells, for example, that the images are not sharp, it is fairly difficult to accurately test the device and get an exact figure which would tell whether the device is functioning properly.

Often subjective evaluation has to be used for finding out if a certain property of the camera is acceptable or not. Some training or experience of a correctly operating reference device may be needed in order to detect what actually is wrong.

It is easy for the user to take bad images in bad conditions. Therefore the camera operation has to be checked always in constant conditions (lighting, temperature) or by using a second, known-to-be good device as reference.

When checking for possible errors in camera functionality, knowing what error is suspected significantly helps the testing by narrowing down the amount of test cases. The following types of image quality problems may be expected to appear:

- Dust (black spots)
- Lack of sharpness
- Bit errors

Terms

Dynamic range	Camera's ability to capture details in dark and bright areas of the scene simultaneously.
Exposure time	Camera modules use silicon sensor to collect light and for forming an image. The imaging process roughly corresponds to traditional film photography, in which exposure time means the time during which the film is exposed to light coming through optics. Increasing the time will allow for more light hitting the film and thus results in brighter image. The operation principle is exactly the same with silicon sensor, but the shutter functionality is handled electronically i.e. there is no mechanical moving parts like in film cameras.
Flicker	Phenomenon, which is caused by pulsating in scene lighting, typically appearing as wide horizontal stripes in an image.
Noise	Variation of response between pixels with same level of input illumination.
Resolution	Usually the amount of pixels in the camera sensor; for example, RM-298/299 has a 640 x 480 pixel sensor resolution. In some occasions the term resolution is used for describing the sharpness of the images.

Sensitivity	Camera module's sensitivity to light. In equivalent illumination conditions, a less sensitive camera needs a longer exposure time to gather enough light in forming a good image. Analogous to ISO speed in photographic film.
Sharpness	Good quality images are 'sharp' or 'crisp', meaning that image details are well visible in the picture. However, certain issues, such as non-idealities in optics or high levels of digital zoom, cause image blurring, making objects in picture to appear 'soft'. Each camera type typically has its own level of performance.

The effect of image taking conditions on image quality

There are some factors, which may cause poor image quality, if not taken into account by the end user when shooting images, and thus may result in complaints. The items listed are normal to camera operation and are not a reason for changing the camera module.

Distance to target

The lens in the module is specified to operate satisfactorily from 20 cm to infinite distance of scene objects. In practice, the operation is such that close objects may be noticed to get more blurred when distance to them is shorter than 20 cm. The lack of sharpness is first visible in full resolution images. If observing just the viewfinder, even very close objects may seem to appear sharp. This is normal; do not change the camera module.

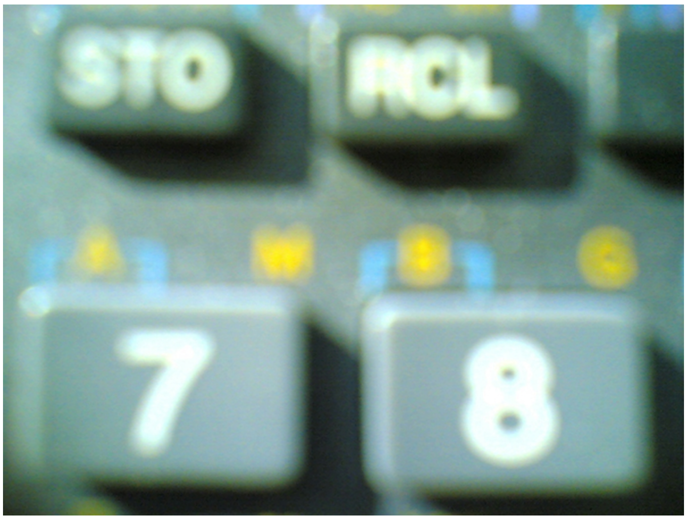


Figure 26 Blurred image. Target too close.

The amount of light available

In dim conditions camera runs out of sensitivity. The exposure time is long (especially in the night mode) and the risk of getting shaken (= blurred) images increases. In addition, image noise level grows. The maximum exposure time in the night mode is ¼ seconds. Therefore, images need to be taken with extreme care and by supporting the phone when the amount of light reflected from the target is low. Because of the longer exposure time and larger gain value, noise level increases in low light conditions. Sometimes blurring may even occur in daytime, if the image is taken very carelessly. See the figure below for an example. This is normal; do not change the camera module.

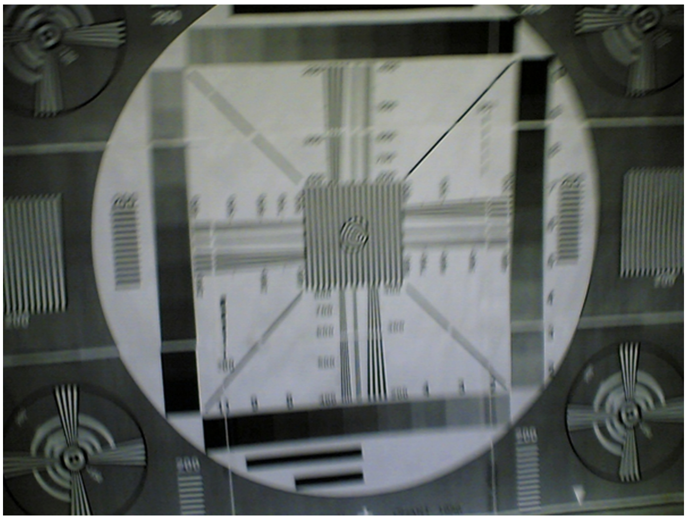


Figure 27 Blurring caused by shaking hands

Movement in bright light

If an image is taken of moving objects or if the device is used in a moving vehicle, object 'skewing' or 'tilting' may occur. This phenomenon is fundamental to most CMOS camera types, and usually cannot be avoided. The movement of camera or object sometimes cause blurring indoors or in dim lighting conditions because of long exposure time. This is normal; do not change the camera module.

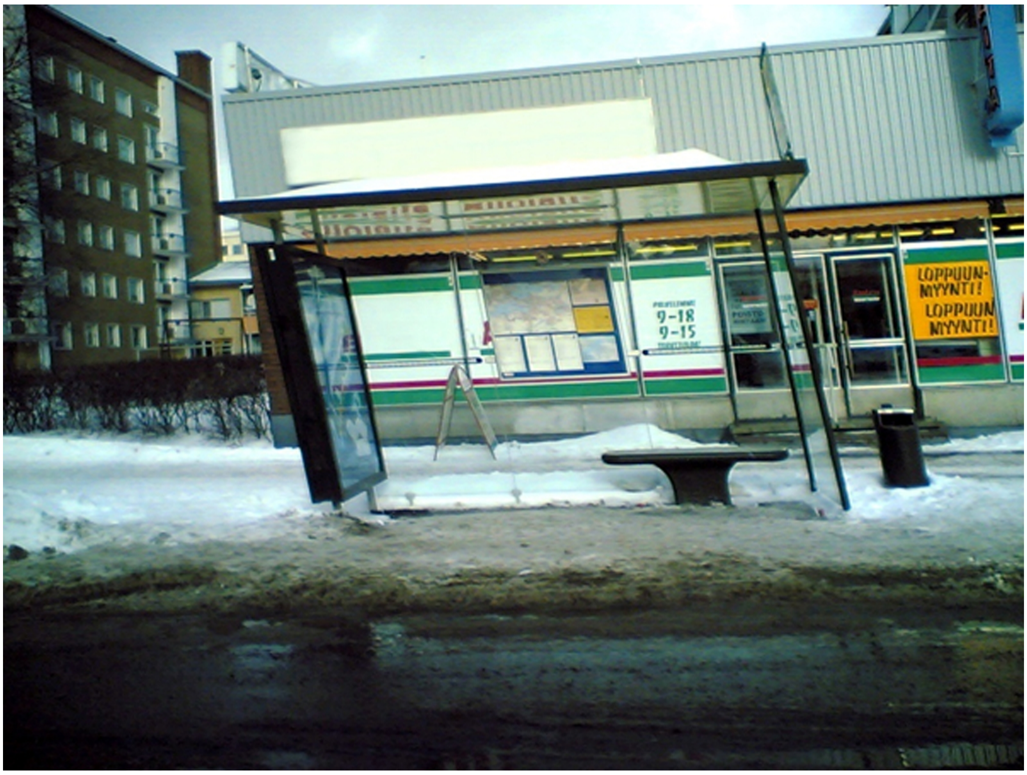


Figure 28 Near objects get skewed when taking images from a moving vehicle

Temperature

High temperatures inside the mobile phone cause more noise to appear in images. For example, in +70 degrees (Celsius), the noise level may be very high, and it further grows if the conditions are dim. If the phone processor has been heavily loaded for a long time before taking an image, the phone might have considerably higher temperature inside than in the surrounding environment. This is also normal to camera operation; do not change the camera module.

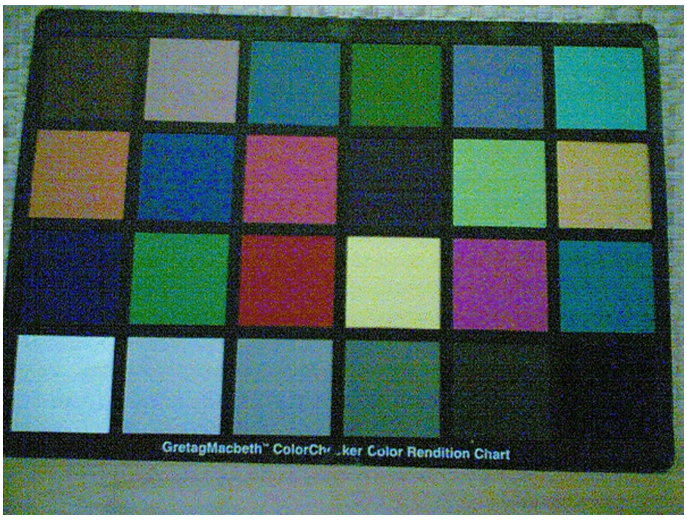


Figure 29 Noisy image taken in +70 degrees Celsius

Phone display

If the display contrast is set too dark, the image quality degrades: the images may be very dark depending on the setting. If the display contrast is set too bright, image contrast appears bad and "faint". This problem is solved by setting the display contrast correctly. This is normal behaviour; do not change the camera module.

Basic rules of photography (especially shooting against light)

Because of dynamic range limitations, taking images against bright light might cause either saturated image or the actual target appear too dark. In practice, this means that when taking an image indoors and having, for example, a window behind the object, the result is usually poor. This is normal behaviour; do not change the camera module.

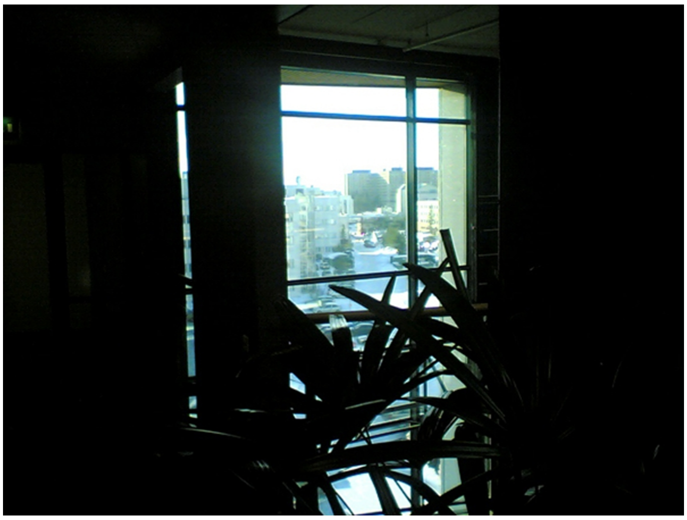


Figure 30 Image taken against light

Flicker

In some occasions a bright fluorescent light may cause flicker in the viewfinder and captured image. This phenomenon may also be a result, if images are taken indoors under the mismatch of 50/60 Hz electricity network frequency. The electricity frequency used is automatically detected by the camera module. In some very few countries, both 50 and 60 Hz networks are present and thus probability for the phenomenon increases. Flickering occurs also under high artificial illumination level. This is normal behaviour; do not change the camera module.

Figure 31 Flicker in an image; object illuminated by strong fluorescent light

Bright light outside of image view

Especially the sun can cause clearly visible lens glare phenomenon and poor contrast in images. This happens because of undesired reflections inside the camera optics. Generally this kind of reflections are common in all optical systems. This is normal behaviour; do not change the camera module.

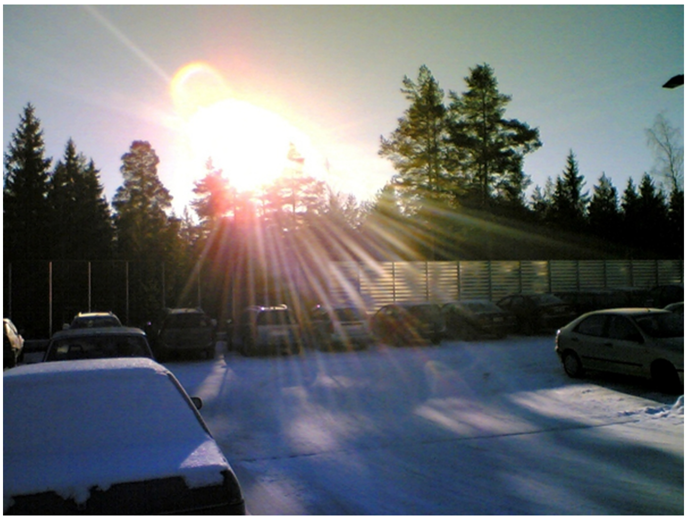


Figure 32 A lens reflection effect caused by sunshine

Examples of good quality images

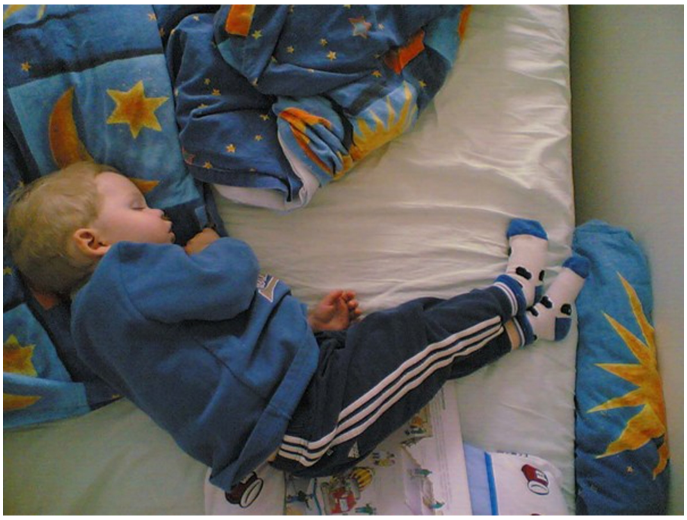


Figure 33 Good image taken indoors

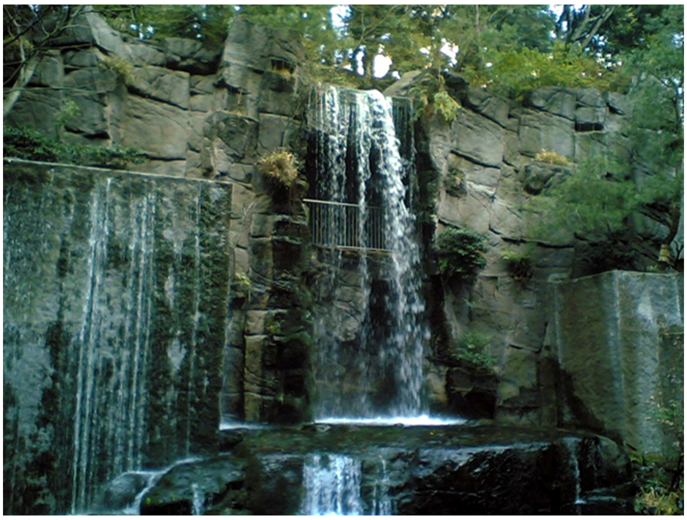


Figure 34 Good image taken outdoors

Camera construction

This section describes the mechanical construction of both camera modules for getting a better understanding of the actual mechanical structure of each module.

Main camera construction

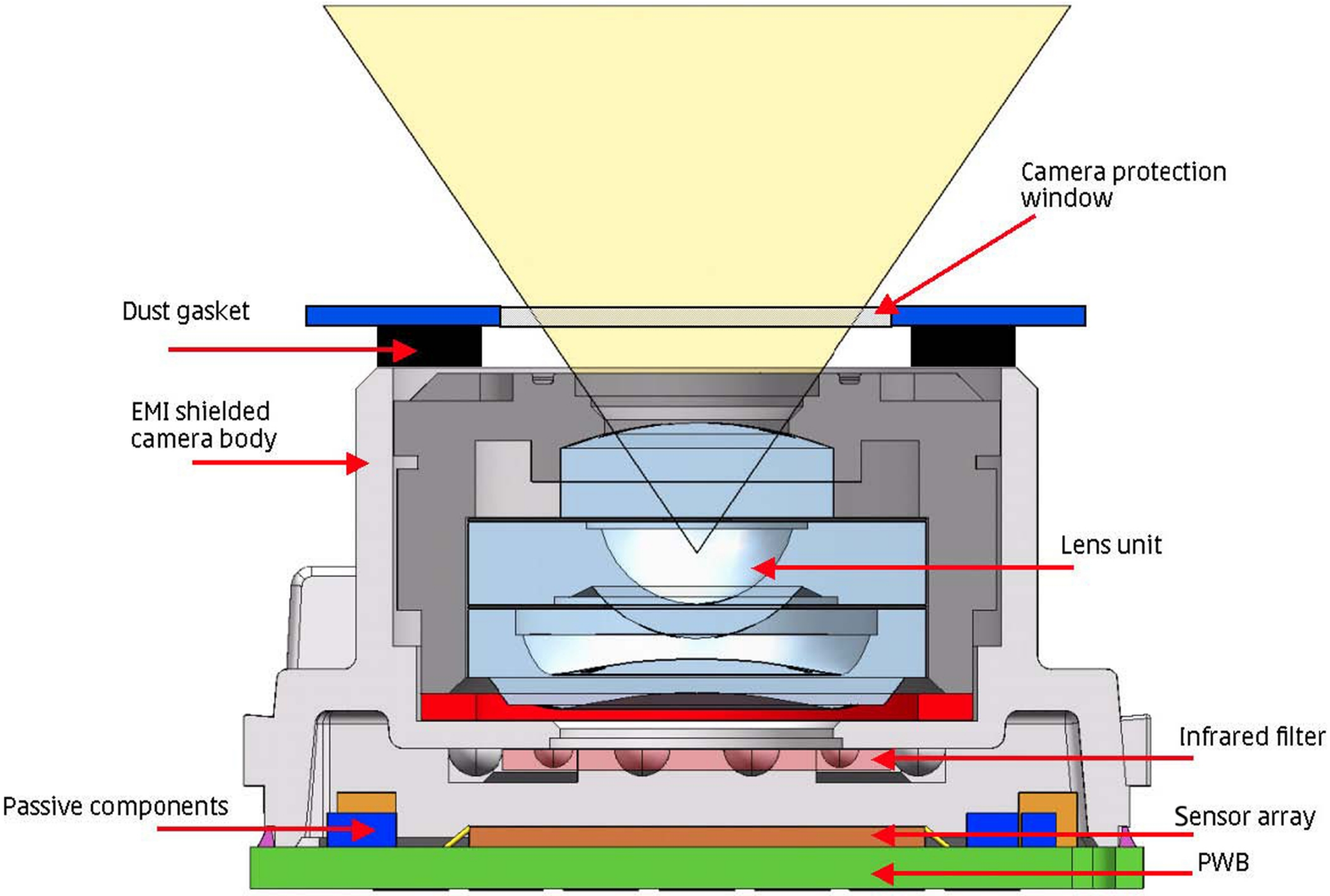

Camera protection window
Dust gasket
EMI shielded camera body
Lens unit
Infrared filter
Passive components
Sensor array
PWB

Figure 35 Camera module cross section and assembly principle

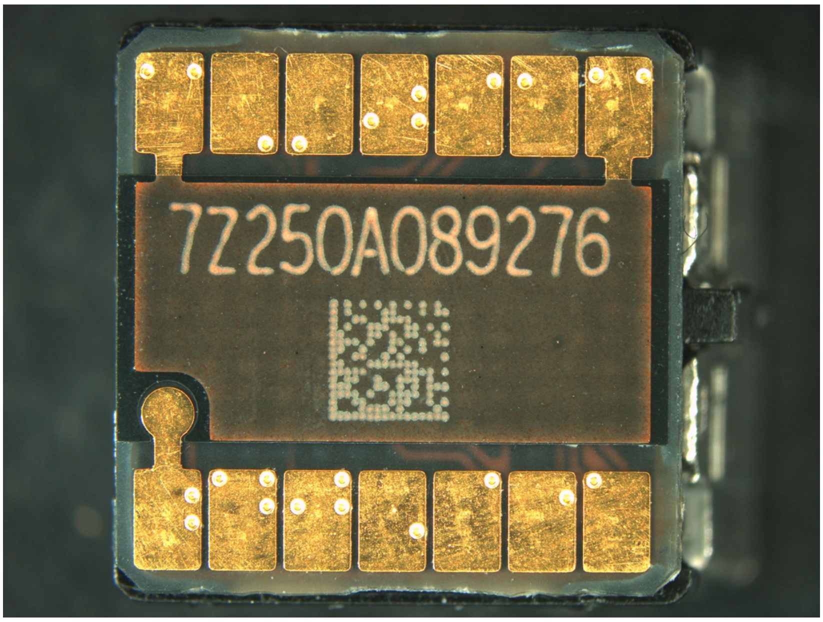

7Z250A089276

Figure 36 Main camera module bottom view including serial numbering

The camera module as a component is not a repairable part, meaning that the components inside the module may not be changed. Cleaning dust from the front face is allowed only. Use clean compressed air.

The camera module uses socket type connecting. For versioning, laser marked serial numbering is used on the PWB.

The main parts of the module are:

- Lens unit including lens aperture.
- Infrared filter; used to prevent infrared light from contaminating the image colors. The IR filter is glued to the EMI shielded camera body.
- Camera body; made of conductive metallized plastic and attached to the PWB with glue.
- Sensor array including DSP functions is glued and wire-bonded to the PWB.
- PWB, FR-4 type
- Socket type connection
- Laser-marked serial numbering on PWB (for versioning)
- Passive components
- Camera protection window; part of the phone cover mechanics
- Dust gasket between the lens unit and camera protection window

Image quality analysis

Testing for dust in camera module

Symptoms and diagnosis

For detecting these kinds of problems, take an image of a uniform white surface and analyse it in full resolution. A good quality PC monitor is preferred for analysis. Search carefully, since finding these defects is not always easy. Figure "Effects of dust on optical path" is an example image containing easily detectable dust problems.

When taking a white image, use uniformly lightened white paper or white wall. One possibility is to use uniform light but in this case make sure that the camera image is not flickering when taking the test image. In case flickering happens, try to reduce illumination level. Use JPEG image format for analysing, and set the image quality parameter to ‘High Quality’.

Black spots in an image are caused by dirt particles trapped inside the optical system. Clearly visible and sharp edged black dots in an image are typically dust particles on the image sensor. These spots are searched for in the manufacturing phase, but it is possible that the camera body cavity contains a particle, which may move onto the image sensor active surface, for example, when the phone is dropped. Thus it is also possible that the problem will disappear before the phone is brought to service. The camera should be replaced if the problem is present when the service technician analyses the phone.

If a dust particle is lying on the infrared filter surface on either side, they are hard to locate because they are out of focus, and appear in the image as large, grayish and fading-edge 'blobs'. Sometimes they are invisible to the eye, and thus the user probably does not notice them at all. However, it is possible that a larger particle disturbs the user, causing need for service.

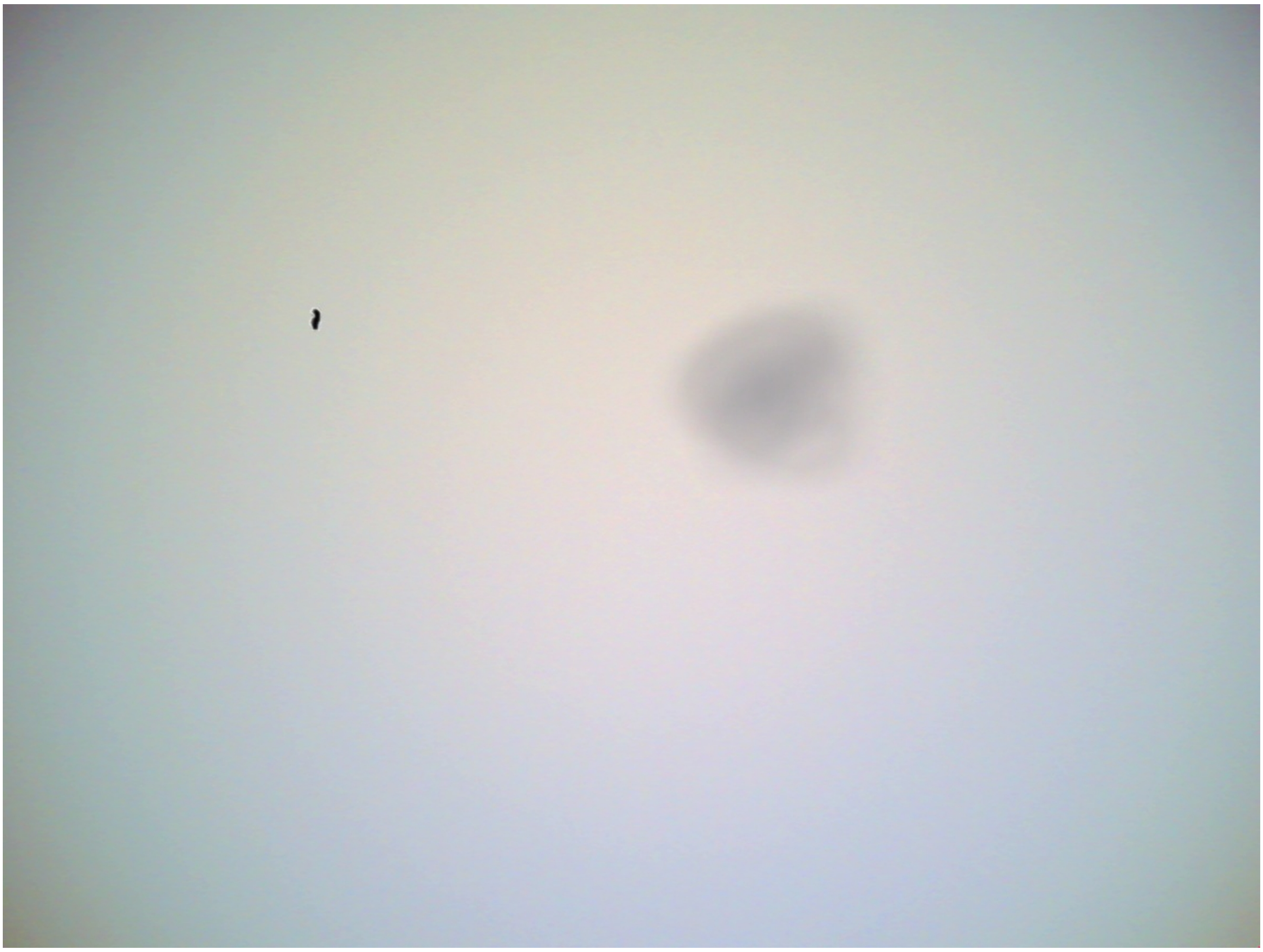


Figure 37 Effects of dust on optical path

If large dust particles get trapped on top of the lens surface in the cavity between camera window and lens, they will cause image blurring and poor contrast. The dust gasket between the window and lens should prevent any particles from getting into the cavity after the manufacturing phase. Dust in this position should be blown away by using compressed air.

Unauthorized disassembling of the product can also be the root of the problem. However, in most cases it should be possible to remove the particle(s) by using clean compressed air. Never wipe the lens surface before trying compressed air; the possibility of damaging the lens is substantial. Always check the image sharpness after removing dust.

Testing camera image sharpness

Symptoms and diagnosis

If pictures taken with a device are claimed to be blurry, there are six possible sources for the problem:

1. The protection window is fingerprinted, soiled, dirty, visibly scratched or broken.
2. The photographed object is too close – the camera lens operates with distances from 20 cm to infinity. This is no cause to replace camera module.
3. User has tried to take pictures in too dark conditions, and images are blurred due to handshake or movement. This is no cause to replace camera module.
4. There is dirt between the protection window and camera lens.

5 The protection window is defective. This can be either a manufacturing failure or caused by the user. The window should be changed.

6 The camera lens is misfocused because of a manufacturing error.

7 Very high level of digital zoom is used

A quantitative analysis of sharpness is very difficult to conduct in any other environment than optics laboratory. Therefore, subjective analysis should be used.

If no visible defects (items 1-4) are found, a couple of test images should be taken. Generally, a well-illuminated typical indoor scene can be used as a target. The main considerations are:

- The protection window has to be clean.
- The amount of light (300 – 600 lux (bright office lighting)) is sufficient.
- The scene should contain, for example, small objects for checking sharpness. Their distance should be 1 – 2 meters.
- If possible, compare the image to another image of the same scene, taken with a different device. Note that the reference device has to be a similar Nokia phone.

Steps

1. Take several images of small objects in the distance of 1-2 metres.
2. Analyse the images on a PC screen at 100% scaling with the reference images.

   Pay attention to the computer display settings: at least 65000 colors (16-bit) have to be used. True colour (24-bit, 16 million colours) or 32-bit (full colour) setting is recommended.

Next actions

If there appears to be a clearly noticeable difference between the reference image and the test images, the module might have a misfocused lens -> change the module.

Re-check the resolution after changing the camera module.

If the changed module produces the same result, the fault is probably in the camera window. Check the window by looking carefully through it when replacing the module.

Dirty camera lens protection window

The following series of images demonstrates the effects of fingerprints on the camera protection window.

It should be noted that the effects of any dirt in images can vary much. It may be difficult to judge whether the window has been dirty or if something else is wrong. Therefore, the cleanness of the protection window should always be checked and the window should be wiped clean with a suitable cloth.

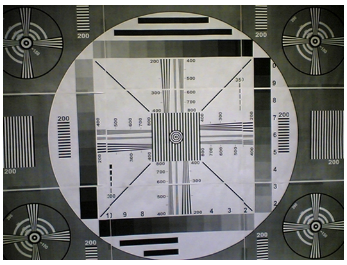


Figure 38 Image taken with clean protection window

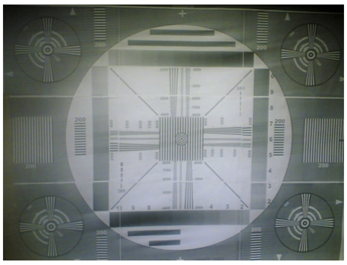


Figure 39 Image taken with greasy protection window

Image bit errors

Bit errors are image defects caused by data transmission errors between the camera module and the phone baseband and/or errors inside the module.

Usually bit errors can be easily detected in images, and they are best visible in full resolution images. A good practice is to use a uniform white test target when analysing these errors. The errors are clearly visible, colourful sharp dots or lines in camera images. See the following figure.

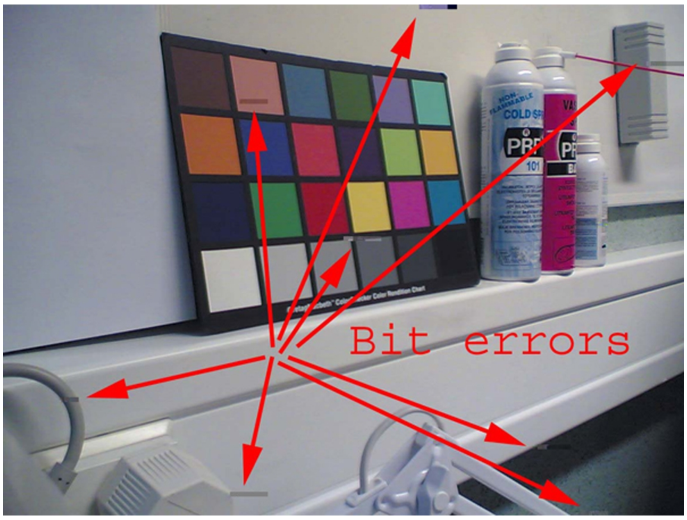


Figure 40 Bit errors caused by JPEG compression

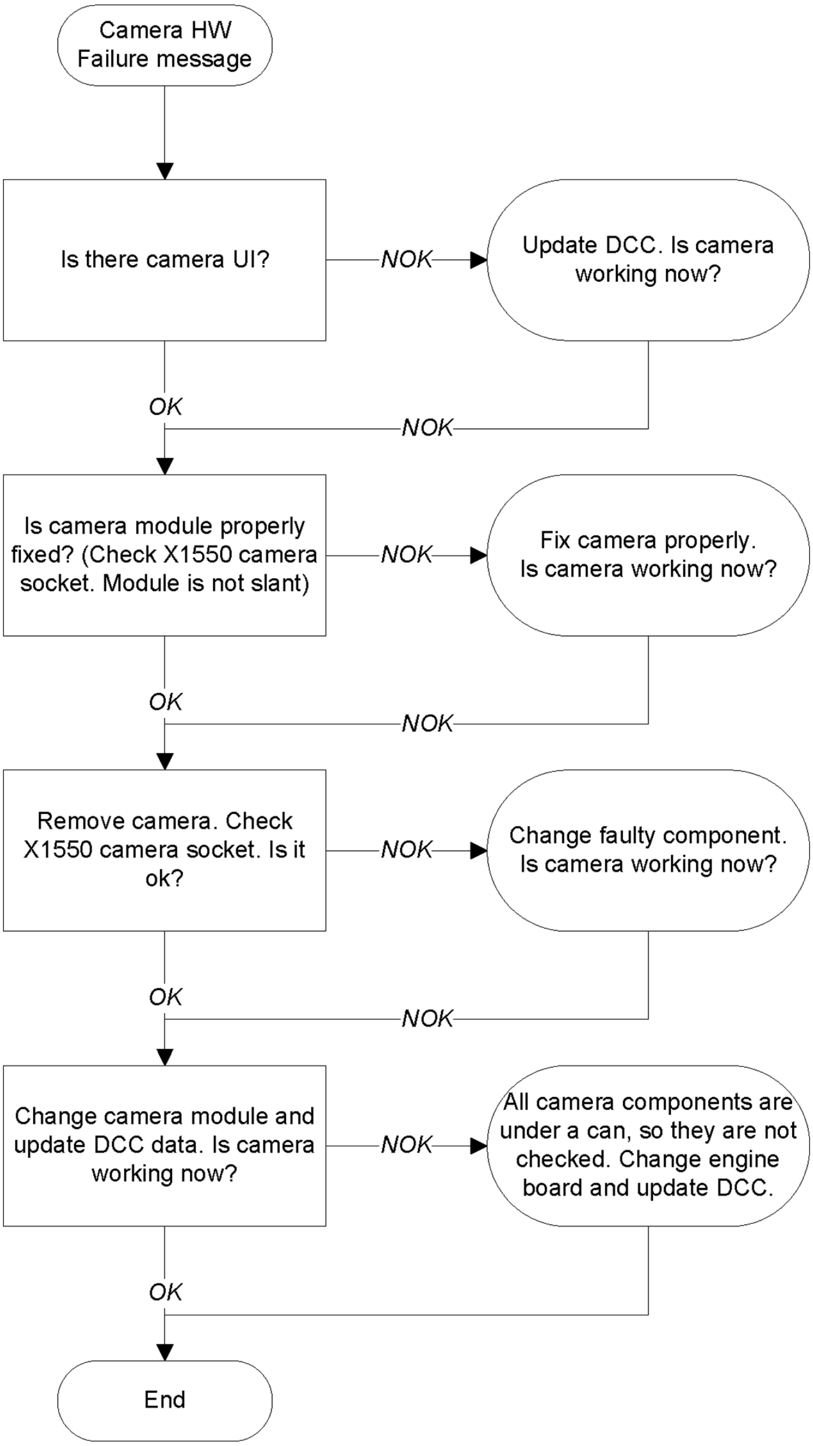
One type of bit error is a lack of bit depth. In this case, the image is almost totally black under normal conditions, and only senses something in very highly illuminated environments. Typically this is a contact problem between the camera module and the phone main PWB. Very black images and viewfinder may also be caused by failure of the 2.8V supply to the camera. You should check the camera assembly and connector contacts.

If the fault is in the camera module, bit errors are typically visible only when using some specific image resolution. For example, in case of a viewfinder fault, the error might exist but is not visible in a full size image.

Camera troubleshooting

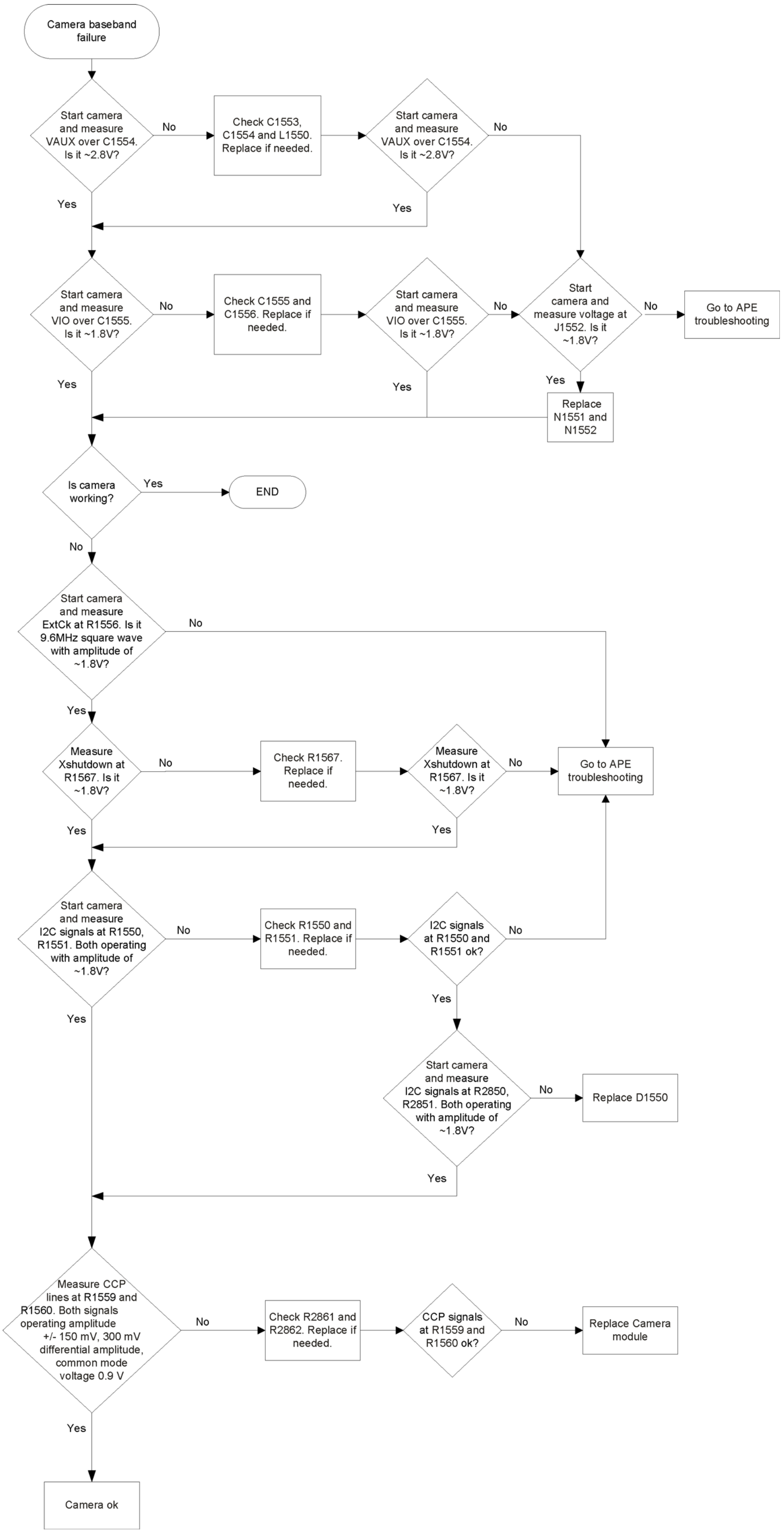
Camera hardware failure troubleshooting

Troubleshooting flow


Camera HW Failure message
Is there camera UI?
NOK
Update DCC. Is camera working now?
OK
NOK
Is camera module properly fixed? (Check X1550 camera socket. Module is not slant)
NOK
Fix camera properly. Is camera working now?
OK
NOK
Remove camera. Check X1550 camera socket. Is it ok?
NOK
Change faulty component. Is camera working now?
OK
NOK
Change camera module and update DCC data. Is camera working now?
NOK
All camera components are under a can, so they are not checked. Change engine board and update DCC.
OK
End

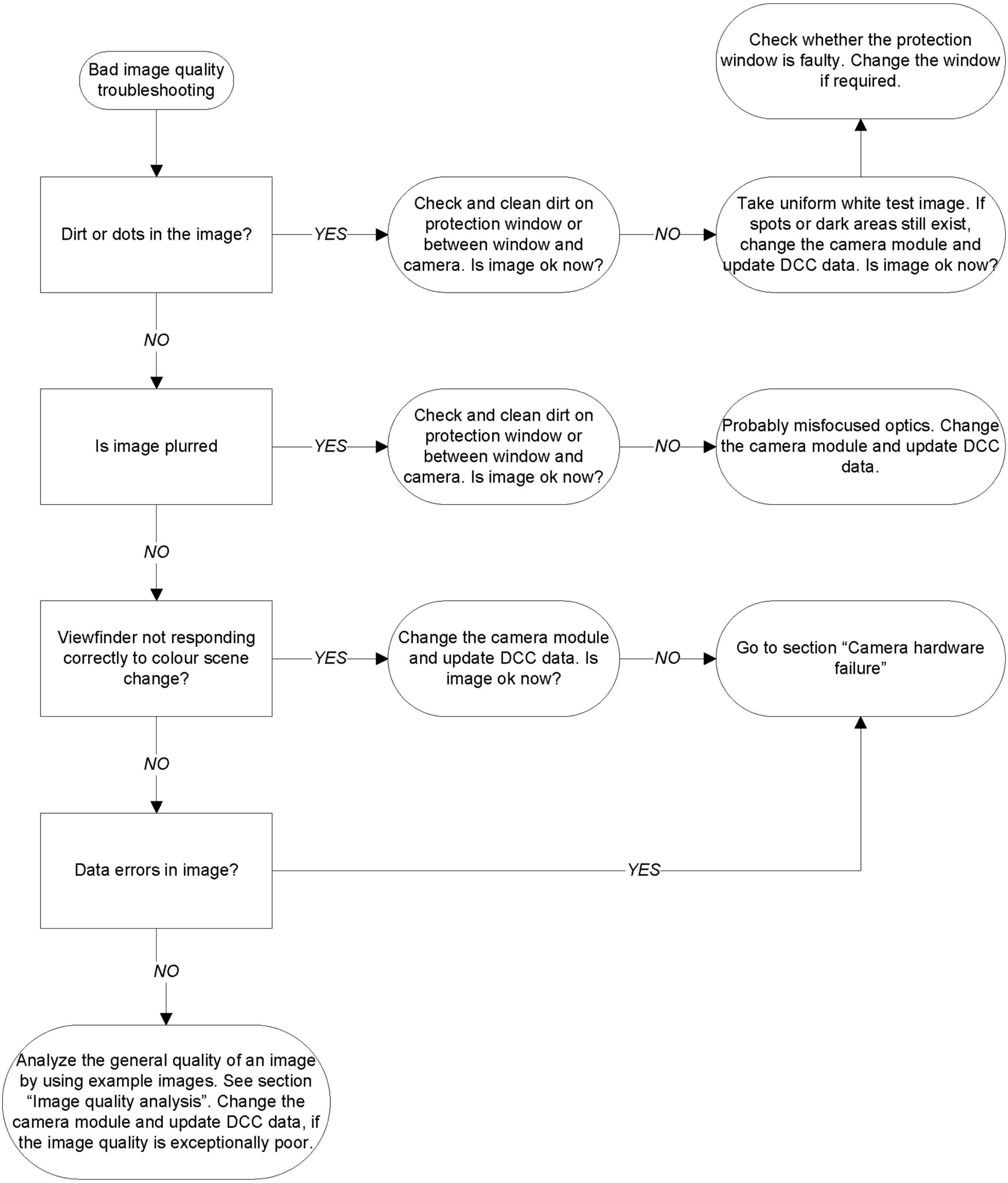
Camera baseband hardware failure troubleshooting

Troubleshooting flow


Camera baseband failure
Start camera and measure VAUX over C1554. Is it ~2.8V?
No
Check C1553, C1554 and L1550. Replace if needed.
Start camera and measure VAUX over C1554. Is it ~2.8V?
No
Yes
Yes
Start camera and measure VIO over C1555. Is it ~1.8V?
No
Check C1555 and C1556. Replace if needed.
Start camera and measure VIO over C1555. Is it ~1.8V?
No
Start camera and measure voltage at J1552. Is it ~1.8V?
No
Go to APE troubleshooting
Yes
Yes
Yes
Replace N1551 and N1552
Is camera working?
Yes
END
No
Start camera and measure ExtCk at R1556. Is it 9.6MHz square wave with amplitude of ~1.8V?
No
Yes
Measure Xshutdown at R1567. Is it ~1.8V?
No
Check R1567. Replace if needed.
Measure Xshutdown at R1567. Is it ~1.8V?
No
Go to APE troubleshooting
Yes
Yes
Start camera and measure I2C signals at R1550, R1551. Both operating with amplitude of ~1.8V?
No
Check R1550 and R1551. Replace if needed.
I2C signals at R1550 and R1551 ok?
No
Yes
Yes
Start camera and measure I2C signals at R2850, R2851. Both operating with amplitude of ~1.8V?
No
Replace D1550
Yes
Measure CCP lines at R1559 and R1560. Both signals operating amplitude +/- 150 mV, 300 mV differential amplitude, common mode voltage 0.9 V
No
Check R2861 and R2862. Replace if needed.
CCP signals at R1559 and R1560 ok?
No
Replace Camera module
Yes
Camera ok

Camera image quality troubleshooting

Troubleshooting flow


Bad image quality troubleshooting
Dirt or dots in the image?
YES
Check and clean dirt on protection window or between window and camera. Is image ok now?
NO
Take uniform white test image. If spots or dark areas still exist, change the camera module and update DCC data. Is image ok now?
Check whether the protection window is faulty. Change the window if required.
NO
Is image plurred
YES
Check and clean dirt on protection window or between window and camera. Is image ok now?
NO
Probably misfocused optics. Change the camera module and update DCC data.
NO
Viewfinder not responding correctly to colour scene change?
YES
Change the camera module and update DCC data. Is image ok now?
NO
Go to section "Camera hardware failure"
NO
Data errors in image?
YES
NO
Analyze the general quality of an image by using example images. See section "Image quality analysis". Change the camera module and update DCC data, if the image quality is exceptionally poor.

Flash LED troubleshooting

Introduction to flash LED troubleshooting

A fault or complaint associated to LED flash operation can be roughly categorized into two subgroups:

1. Flash is not functional at all (no light output at all).
2. Images can be taken and they are recognizable but for some reason the quality of images is degraded.

   Examples of quality degradations:

   - Brightness is not sufficient.
   - Brightness is too much = overexposed.
   - Only portions of the image brightness (e.g., left, right, top or bottom) are proper and the rest are not.

The quality of an image is very difficult to measure quantitatively, and even comparative measurements are difficult (comparing two images), if the difference between reference images is small. If a user is not satisfied with his/her device's image quality, it is fairly difficult to accurately test the device and get an exact result, which would tell if the device is working properly.

Often subjective evaluation has to be used for finding out if there is something wrong in the flash. Some training or experience of a correctly operating reference device may be needed in order to detect possible faults. It is easy for a user to take low quality images in bad conditions. Therefore, the camera and flash operation has to be always checked in constant conditions (lighting, temperature) or by using a second, known-to-be good reference device.

Flash LED and image taking conditions

This section describes some of common factors, which may cause poor image quality if not taken into account by end users when taking pictures, and may therefore result in complaints. The items described are normal to the camera and LED flash operation and do not raise a need for servicing the components.

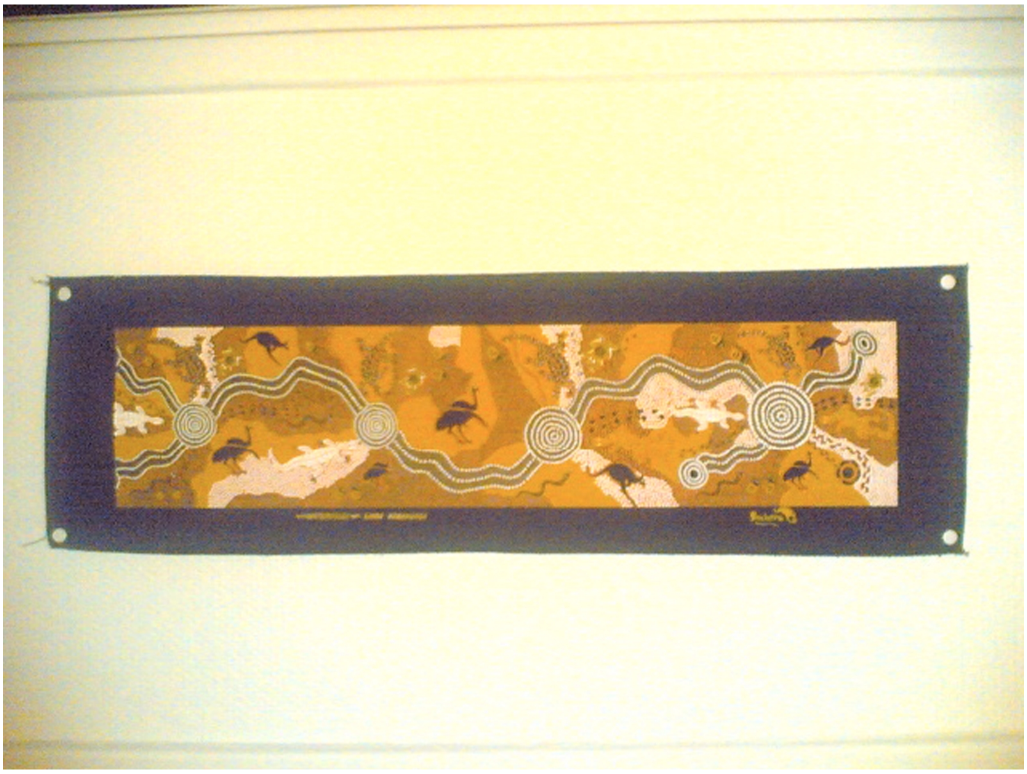


Figure 41 Example of a good quality image taken with the flash LED

Distance to the target (too close)

There is no feedback in the flash system, which means that the light output is constant in every situation. This causes the images to overexposure, when shot from close distance. The flash LED is designed to work optimally between distances of 70 cm – 1.2 m.

This is normal behaviour; do not change the flash module.

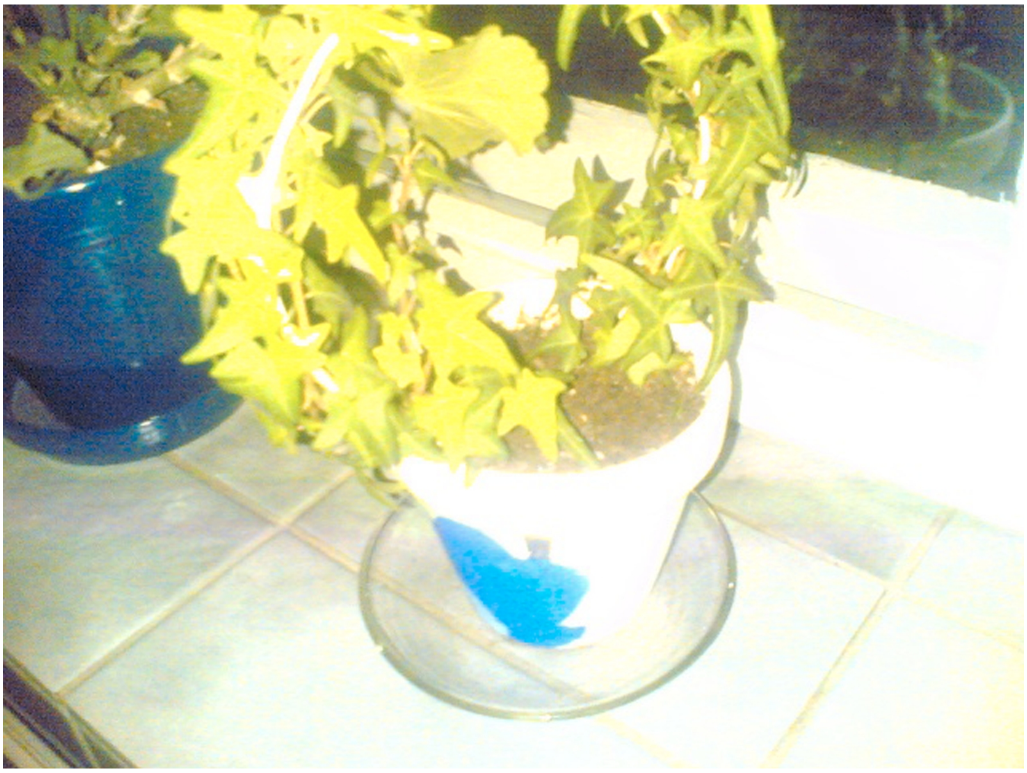


Figure 42 overexposed image

Distance to the target (too far away):

The power of the white LED flash is still very modest compared to xenon flash technology. Even with full power, the maximum distance for an acceptable image quality is roughly 1.2 m. If the distance is greater than 1.2 m, the images will appear dark and the noise level increases.

This is normal behaviour; do not change the flash module.

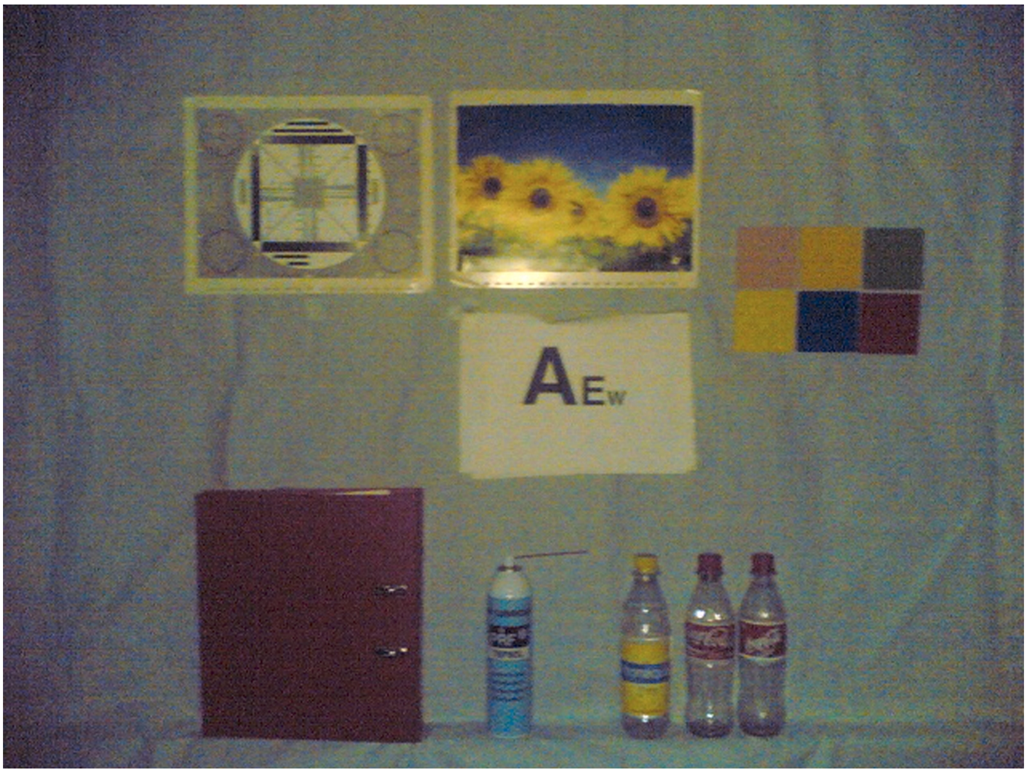


Figure 43 Dark and noisy image

Shaken (= blurred) images

The traditional xenon flash has the advantage of stopping the movement. This is a result of an extremely short and intense light pulse, which makes it possible for a camera to use very short exposure time. Due to the weak output of the LED flash, the exposure time has to be actually increased in the viewfinder mode in total blackness, instead of shortening it. This allows the sensor to integrate longer and collect more light but this also easily creates blurred images if care is not taken.

In addition to the limitation due to small LED flash light, handshake owing to camcoder type product concept and shutter button operation exists. These are not errors but a limitation of the product. No need to change the LED flash module.

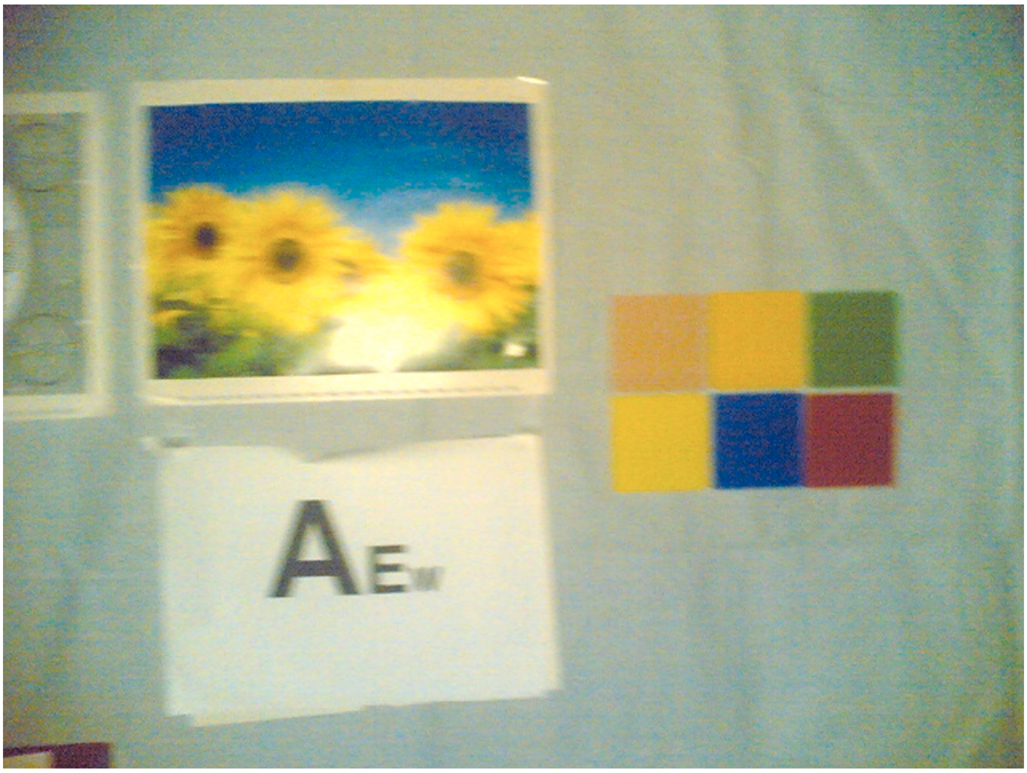


Figure 44 Shaken image

Camera white balance failure and overexposure due to presence of ambient light

Because the spectral output of the flash is known, the white balance and the exposure control of the camera work in optimal way with the flash in total blackness. This is why some of the pictures may fail (i.e. images get a bit yellow or reddish, or greenish or bluish, depending on the ambient light characteristics, as well as overexposed or underexposed).

If the flash works correctly in dark conditions, there is no need to change the flash module.

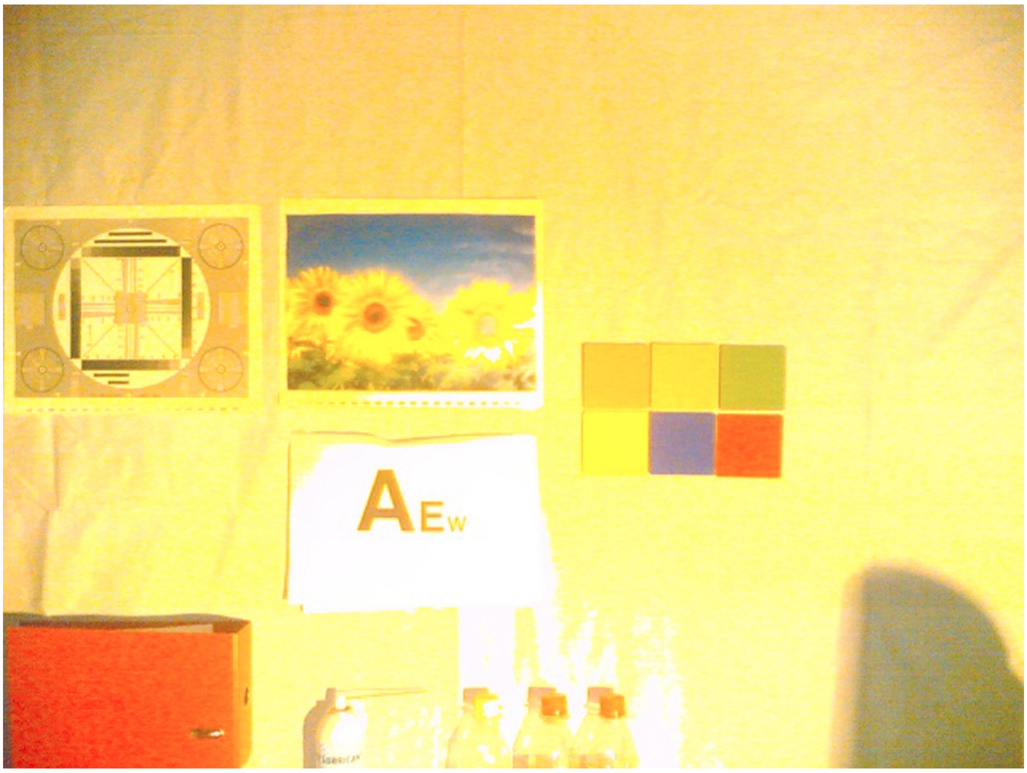


Figure 45 Camera white balance failure and overexposure

Colour difference between different modules

There is some variation in the spectrum of the flash, which derives from the manufacturing process of the white LEDs. Because of this variation, there may be some variation in the colour of the images as well.

This is normal behaviour; do not change the flash module.

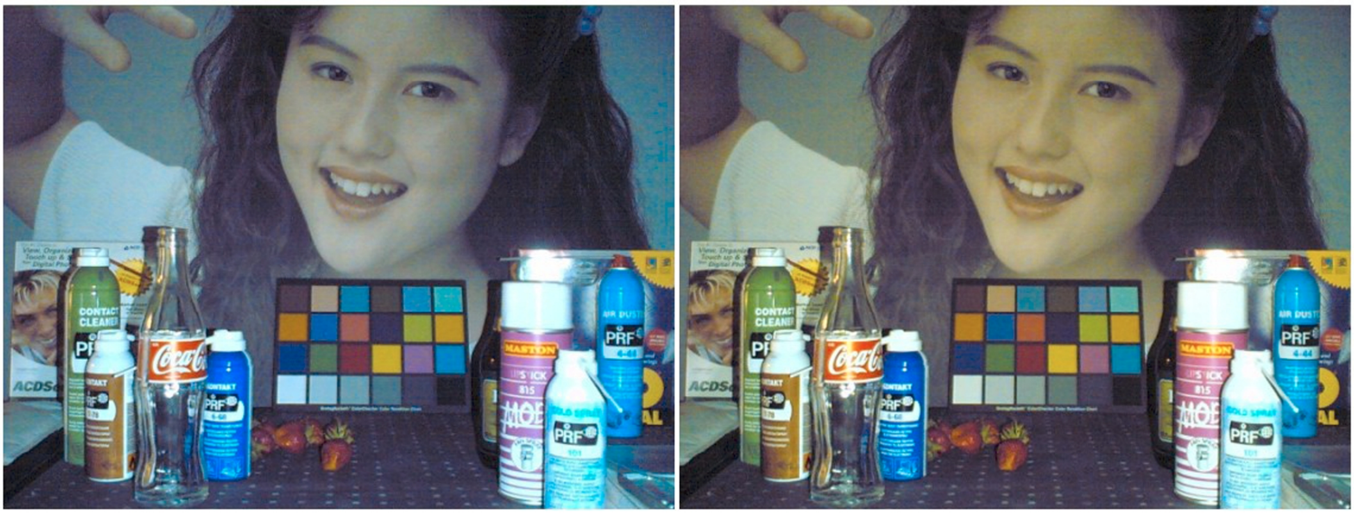
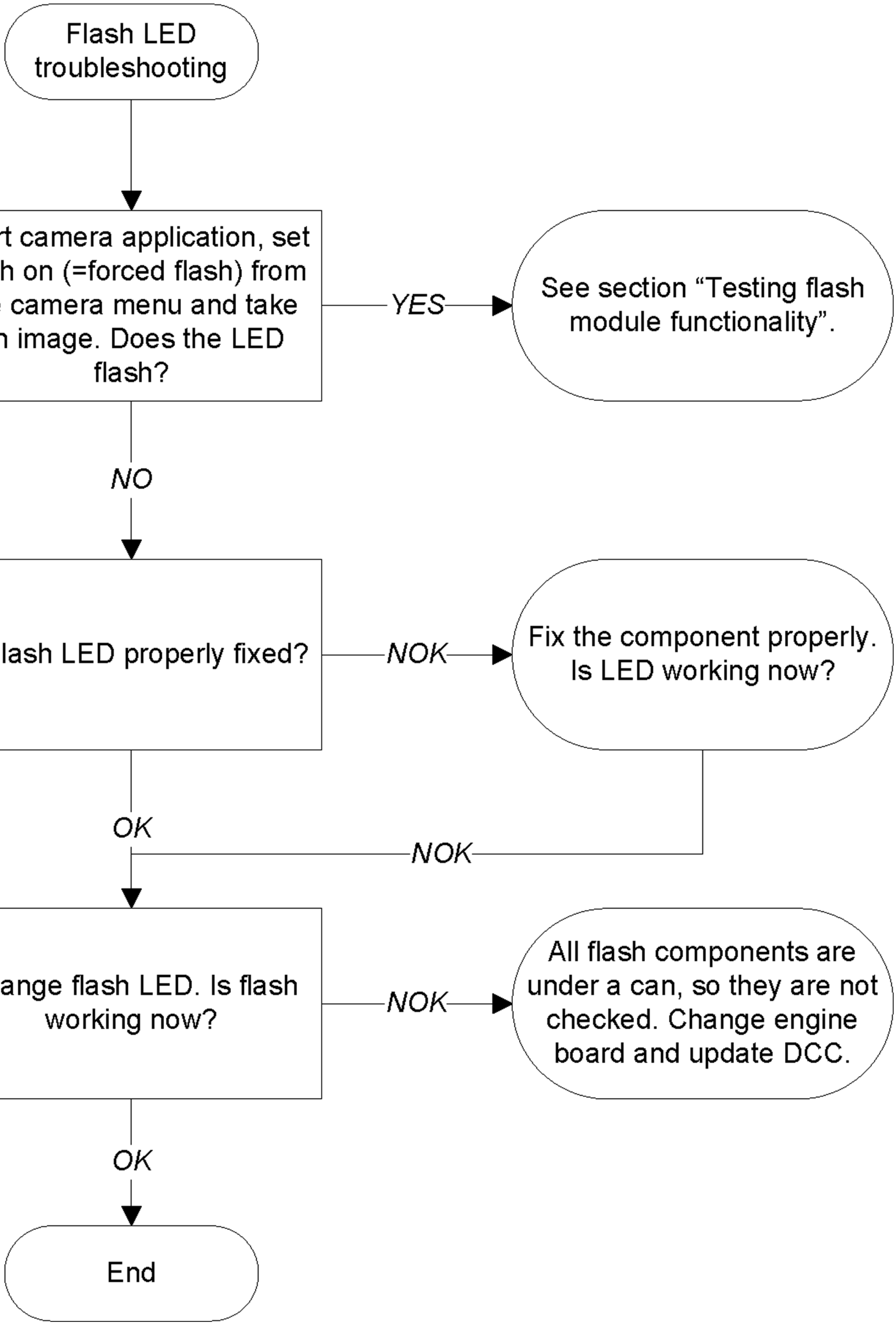


Figure 46 Color difference between flash colour limit samples

Camera flash LED troubleshooting

Troubleshooting flow


Flash LED troubleshooting
Start camera application, set flash on (=forced flash) from the camera menu and take an image. Does the LED flash?
YES
See section "Testing flash module functionality".
NO
Is Flash LED properly fixed?
NOK
Fix the component properly. Is LED working now?
OK
NOK
Change flash LED. Is flash working now?
NOK
All flash components are under a can, so they are not checked. Change engine board and update DCC.
OK
End

Note: The device implements a flash light for taking pictures in dark conditions and which is also used as notification light in video recording mode. In notification mode flash LED is driven with indication current. For notification light troubleshooting, Camera flash LED troubleshooting flow chart can be used.

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6 — System Module and User Interface

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Figure 51 Charger connector 6–25

Introduction

Phone description

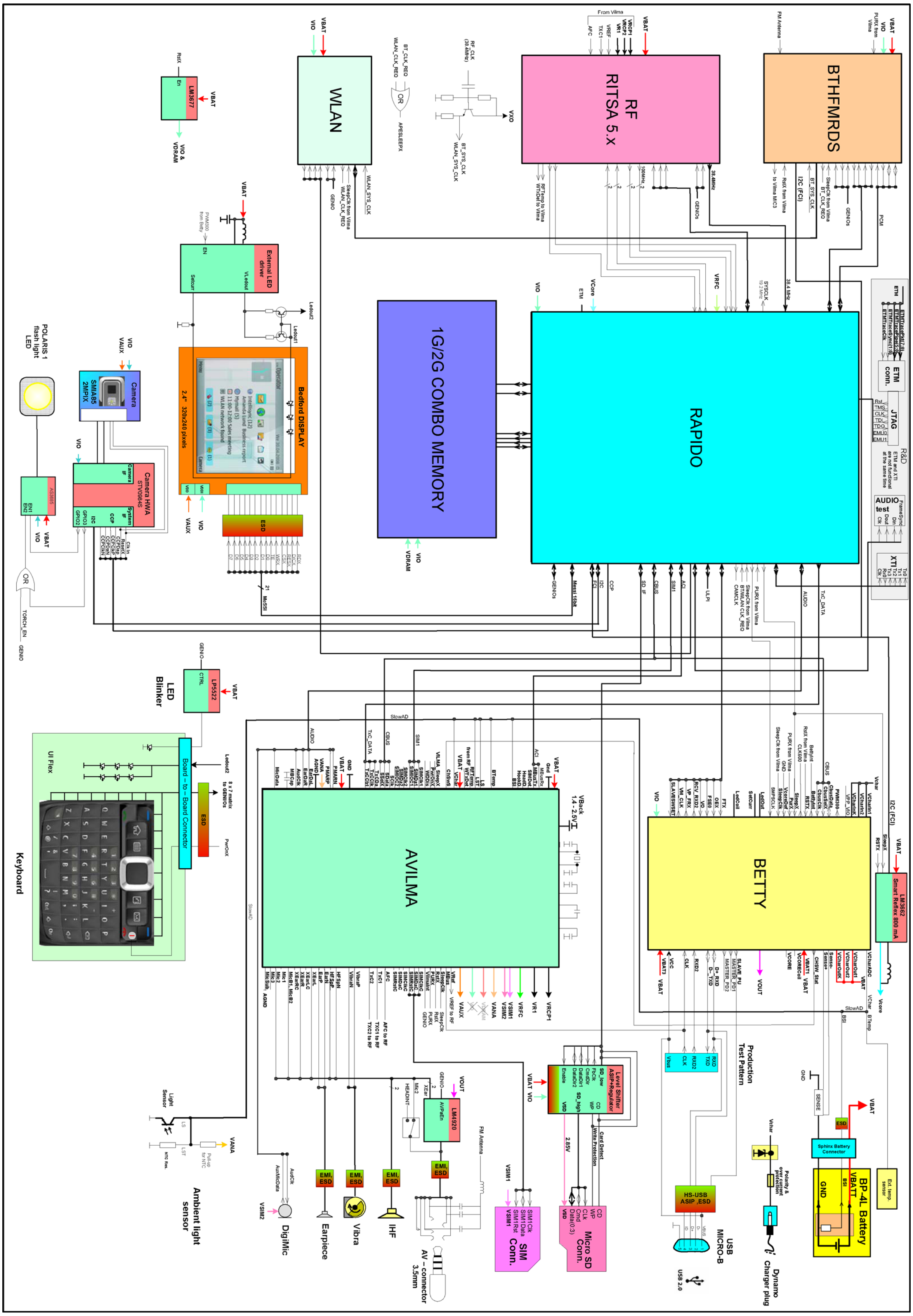
RAPIDO is the main digital baseband ASIC in the phone. It contains functionality for both WCDMA and GSM EDGE.

AVILMA is mainly the audio ASIC in the phone and BETTY is basically the energy management controller for the phone.

Key components

Function	Description	Item ref
Baseband ASIC	AVILMA BETTY	N2200 N2300
RF ASIC	Ahneus	N7505
Processor	RAPIDO	D2800
Camera accelerator	STV984	D1550
PA GSM	Front end module (FEM), quad band	N7520
PA WCDMA	Dual band power amplifier	N7540
Oscillators	VCTCXO	G7501
Memory	1Gb DDR SDRAM + 2Gb M3 Nand FLASH Combo	D3000
Back-up battery	RTC back-up battery 311	G2200
Bluetooth/FM-radio	BthFMRDS2.0D	N6000
WLAN	WLAN_Cost_3.2	N6300
Battery	BP-4L	
Battery connector	Tabby blade interface	X2070
RF connector	Switching co-axial RF test connector for CMT-RF Switching co-axial RF test connector for WLAN	X7501 X6300

System module block diagram


BTHFMRDS
RF
RITSA 5.x
WLAN
RAPIDO
1G/2G COMBO MEMORY
ETM conn.
JTAG
R&D
AUDIO test
XTI
External LED driver
LM3677
Bedford DISPLAY
2.4" 320x240 pixels
ESD
Camera
SMIA85 2MPIX
Camera HWA STV0986S
POLARIS 1 flash light LED
LED Blinker
LP5522
UI Flex
Board - to - Board Connector
Keyboard
AVILMA
BETTY
LM3662 Smart Reflex 800 mA
Production Test Pattern
Level Shifter ASIP+Regulator
LM4920
EMI, ESD
HS-USB ASIP, ESD
Sphinx Battery Connector
BP-4L Battery
Ext. temp. sensor
Ambient light sensor
DigiMic
Earpiece
Vibra
IHF
AV - connector 3.5mm
SIM Conn.
Micro SD Conn.
USB MICRO-B
USB 2.0
Dynamo Charger plug

Energy management

Battery and charging

BP-4L battery

The phone is powered by a 3-pole BP-4L battery S-pack 1500 mAh battery. The three poles are named VBAT, BSI and GND where the BSI line is used to recognize the battery capacity. This is done by means of an internal battery pull down resistor.

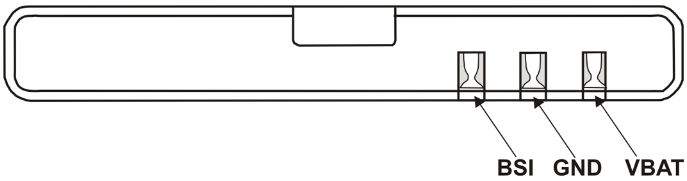


Figure 47 Battery pin order

The battery temperature is estimated by measuring separate battery temperature NTC via the BTEMP line. This is located on the main PWB, at the place where the phone temperature is closest to the battery temperature.

Battery connector

The battery connector is a blade connector. It has three blades;

- BSI (Battery size indicator)
- GND (Ground)
- VBAT (Battery voltage)

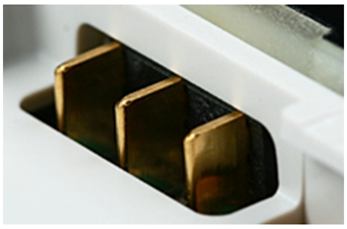


Figure 48 Blade battery connector

Charging

This phone is charged through the smaller Nokia standard interface (2.0 mm plug). The wider standard charger (3.5 mm) can be used together with the CA-44 charger adapter.

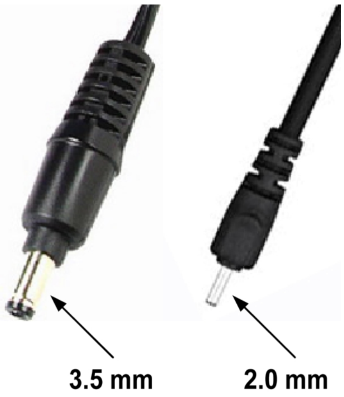


Figure 49 Small (right) and wide (left) charger plugs

Charging is controlled by energy management, and external components are needed to protect the baseband module against EMC, reverse polarity and transient frequency deviation.

Backup battery

When the main battery is not attached EM ASIC (N2200) goes in backup mode using back-up battery that supplies voltage to RTC in EM ASIC (N2200).

Normal and extreme voltages

Energy management is mainly carried out in the two Application Specific Integrated Circuits (ASICs) BETTY and AVILMA. These two circuits contains a number of regulators. In addition there are some external regulators too.

In the table below normal and extreme voltages are shown when a BP-4L battery is used.

Table 14 Nominal voltages

Voltage	Voltage [V]	Condition
General Conditions		
Nominal voltage	3.700	
Lower extreme voltage	3.145	
Higher extreme voltage	4.230	
(fast charging)		
HW Shutdown Voltages		
Vmstr+	2.1 ± 0.1	Off to on
Vmstr-	1.9 ± 0.1	On to off
SW Shutdown Voltages		
Sw shutdown	3.1	In call
Sw shutdown	3.2	In idle
Min Operating Voltage		
Vcoff+	2.9 ± 0.1	Off to on
Vcoff-	2.6 ± 0.1	On to off

Power key and system power-up

When the battery is placed in the phone the power key circuits are energized. When the power key is pressed, the system boots up (if an adequate battery voltage is present).

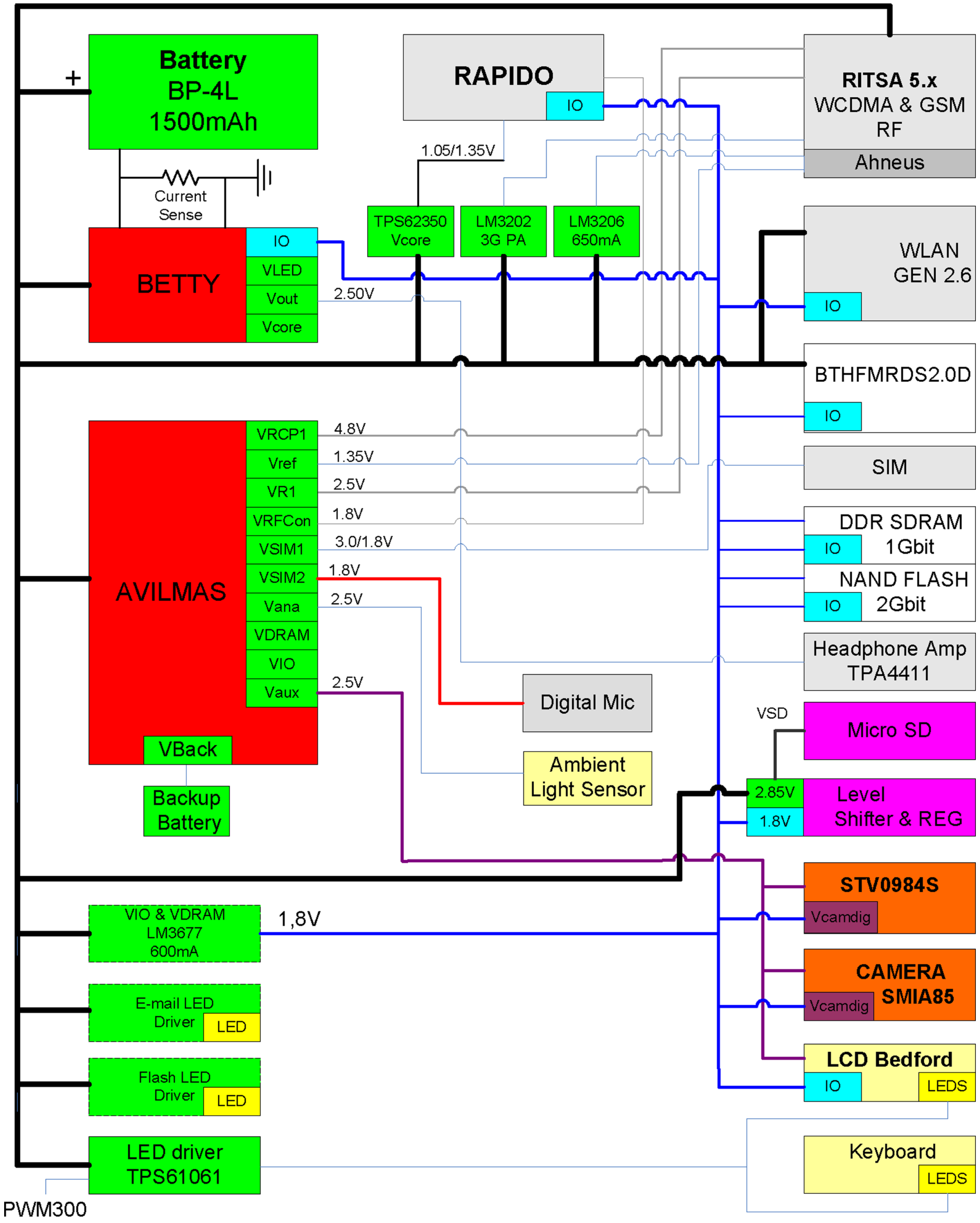
Power down can be initiated by pressing the power key again (the system is powered down with the aid of SW). The power key is connected to EM ASIC N2200 (AVILMA) via PWRONX signal.

Modes of operation

Mode	Description
NO_SUPPLY	(dead) mode means that the main battery is not present or its voltage is too low (below N2200 AVILMA master reset threshold) and that the back-up battery voltage is too low.
BACK_UP	The main battery is not present or its voltage is too low but back-up battery voltage is adequate and the 32 kHz oscillator is running (RTC is on).

Mode	Description
PWR_OFF	In this mode (warm), the main battery is present and its voltage is over N2300 BETTY master reset threshold. All regulators are disabled, PurX is on low state, the RTC is on and the oscillator is on. PWR_OFF (cold) mode is almost the same as PWR_OFF (warm), but the RTC and the oscillator are off.
RESET	RESET mode is a synonym for start-up sequence. RESET mode uses 32 kHz clock to count the REST mode delay (typically 16ms).
SLEEP	SLEEP mode is entered only from PWR_ON mode with the aid of SW when the system's activity is low.
FLASHING	FLASHING mode is for SW downloading.

Power distribution


+
Battery
BP-4L
1500mAh
Current
Sense
BETTY
IO
VLED
Vout
Vcore
2.50V
RAPIDO
IO
1.05/1.35V
TPS62350
Vcore
LM3202
3G PA
LM3206
650mA
RITSA 5.x
WCDMA & GSM
RF
Ahneus
WLAN
GEN 2.6
IO
BTHFMRDS2.0D
IO
SIM
DDR SDRAM
1Gbit
IO
NAND FLASH
2Gbit
IO
Headphone Amp
TPA4411
AVILMAS
VRCP1
Vref
VR1
VRFCon
VSIM1
VSIM2
Vana
VDRAM
VIO
Vaux
4.8V
1.35V
2.5V
1.8V
3.0/1.8V
1.8V
2.5V
2.5V
VBack
Backup
Battery
Digital Mic
Ambient
Light Sensor
VSD
Micro SD
2.85V
1.8V
Level
Shifter & REG
STV0984S
Vcamdig
CAMERA
SMIA85
Vcamdig
LCD Bedford
IO
LEDS
Keyboard
LEDS
VIO & VDRAM
LM3677
600mA
1,8V
E-mail LED
Driver
LED
Flash LED
Driver
LED
LED driver
TPS61061
PWM300

Clocking scheme

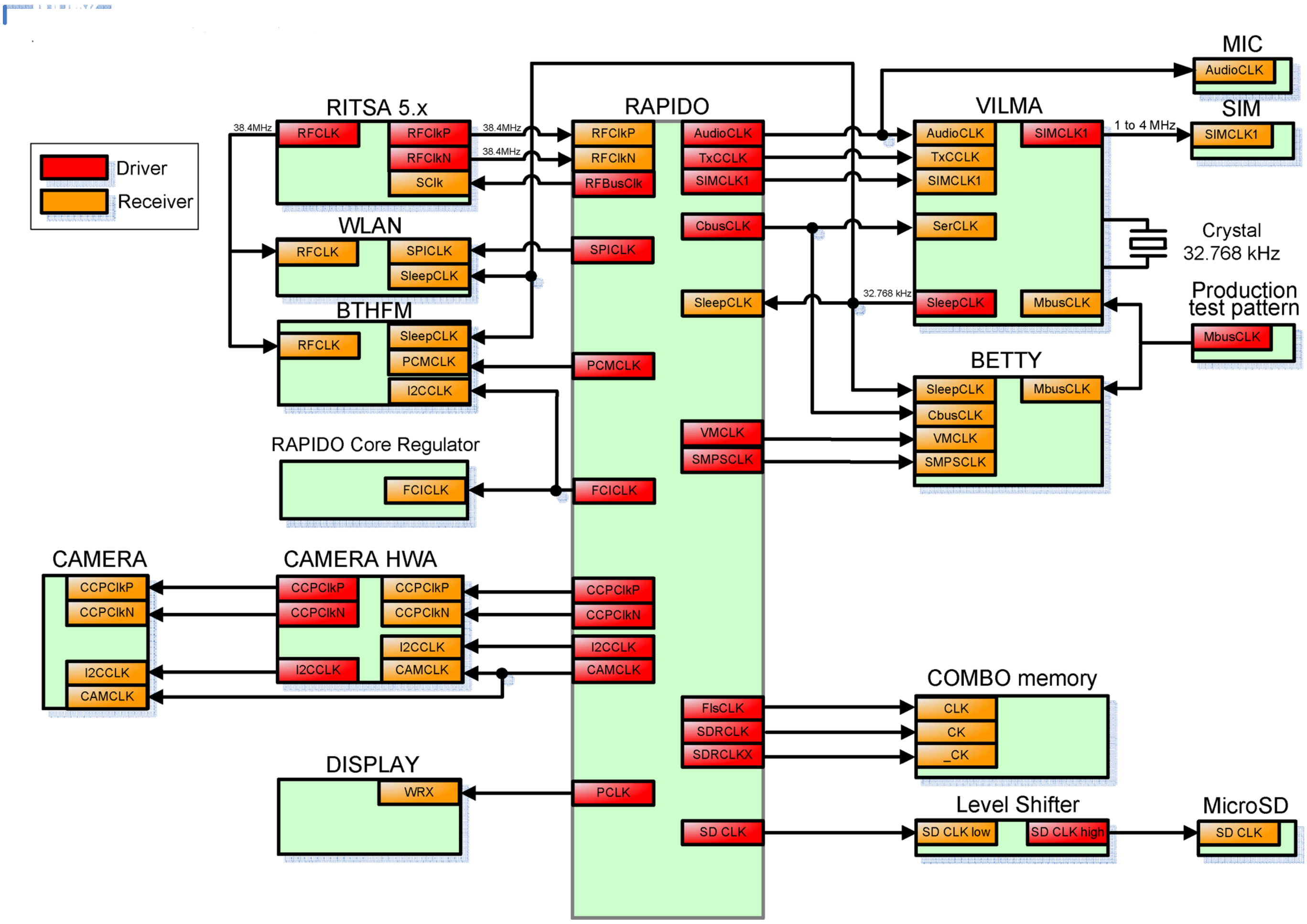
In BB5, two main clocks are provided to the system: 38.4MHz RF clock produced by VCTCXO in RF section and 32.768kHz sleep clock produced by AVILMA with an external crystal.

32 k Sleep Clock is always powered on after startup. Sleep clock is used by RAPIDO for low-power operation.

SMPS Clk is 2.4 MHz clock line from RAPIDO to BETTY. In deep sleep mode, when VCTCXO is off, this signal is set to '0'-state.

BT Clk is 38.4MHz signal from RF VCTCXO to BT chip via BT/WLAN clock buffer.

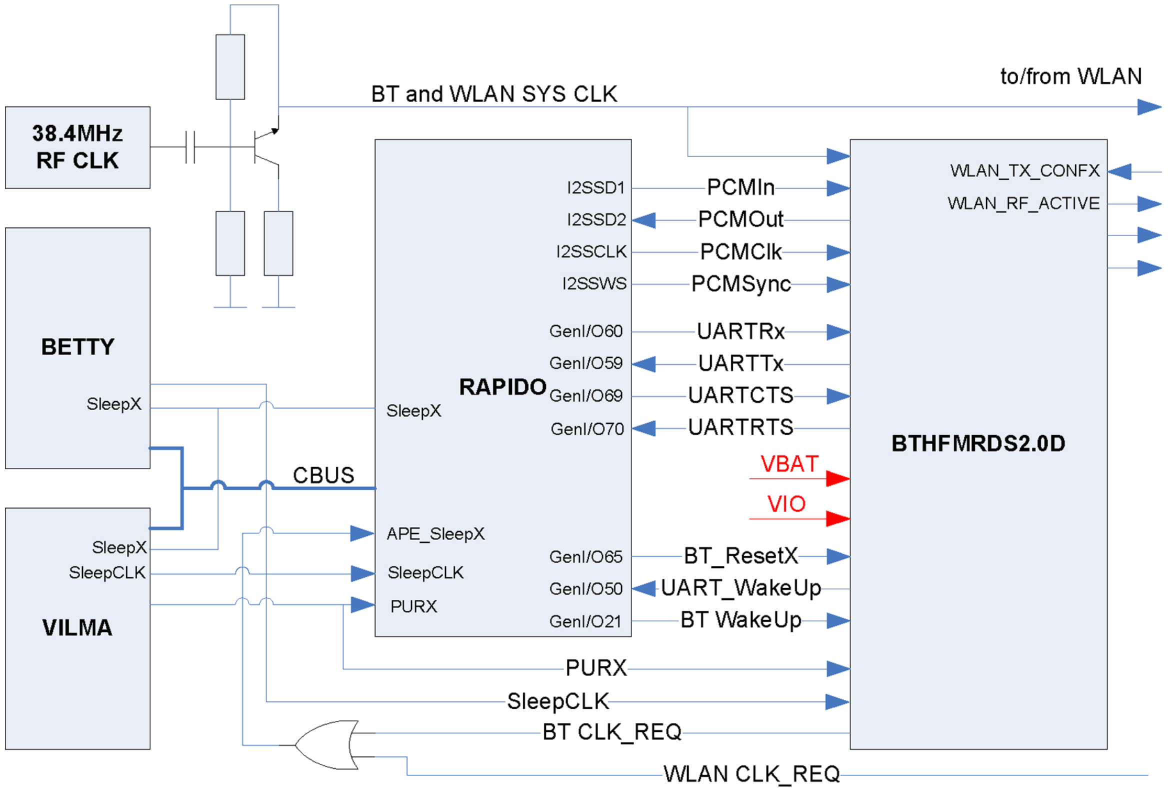
CLK600. The clock source is internal RC oscillator in BETTY (during the power-up sequence) or RAPIDO SMPS Clk.


Driver
Receiver
RITSA 5.x
38.4MHz
RFCLK
RFClkP
RFClkN
SClk
38.4MHz
38.4MHz
WLAN
RFCLK
SPICLK
SleepCLK
BTHFM
RFCLK
SleepCLK
PCMCLK
I2CCLK
RAPIDO Core Regulator
FCICLK
RAPIDO
RFClkP
RFClkN
RFBusClk
AudioCLK
TxCCLK
SIMCLK1
CbusCLK
SPICLK
SleepCLK
PCMCLK
VMCLK
SMPSCLK
FCICLK
CCPClkP
CCPClkN
I2CCLK
CAMCLK
FlsCLK
SDRCLK
SDRCLKX
PCLK
SD CLK
MIC
AudioCLK
SIM
SIMCLK1
VILMA
AudioCLK
TxCCLK
SIMCLK1
SerCLK
SleepCLK
SIMCLK1
MbusCLK
1 to 4 MHz
32.768 kHz
Crystal
32.768 kHz
Production
test pattern
MbusCLK
BETTY
SleepCLK
CbusCLK
VMCLK
SMPSCLK
MbusCLK
CAMERA
CCPClkP
CCPClkN
I2CCLK
CAMCLK
CAMERA HWA
CCPClkP
CCPClkN
I2CCLK
CCPClkP
CCPClkN
I2CCLK
CAMCLK
COMBO memory
CLK
CK
_CK
DISPLAY
WRX
Level Shifter
SD CLK low
SD CLK high
MicroSD
SD CLK

Bluetooth

Bluetooth provides a fully digital link for communication between a master unit (the phone) and one or more slave units (e.g. a wireless headset). Data and control interface for a low power RF module is provided by the module.

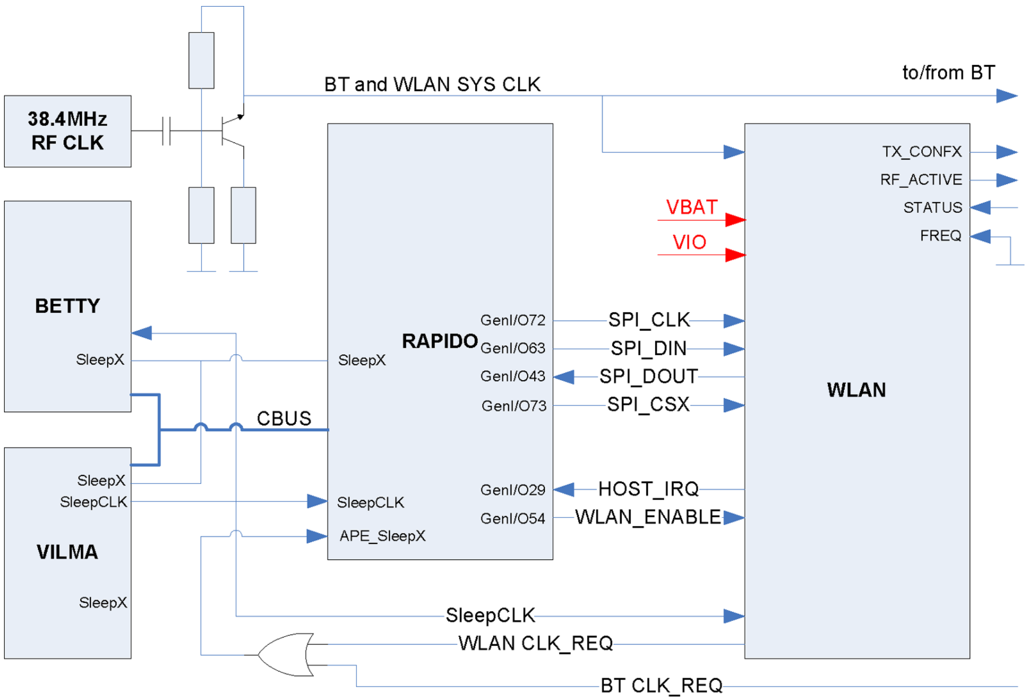
The Bluetooth has a separate built in antenna and is powered by VBAT and the regulated voltage VIO. For audio applications the Bluetooth has a PCM data bus. In addition a UART (universal asynchronous receiver/transmitter) is used for data communication and controls.


38.4MHz RF CLK
BT and WLAN SYS CLK
to/from WLAN
BETTY
SleepX
VILMA
SleepX
SleepCLK
CBUS
RAPIDO
SleepX
APE_SleepX
SleepCLK
PURX
I2SSD1
I2SSD2
I2SSCLK
I2SSWS
GenI/O60
GenI/O59
GenI/O69
GenI/O70
GenI/O65
GenI/O50
GenI/O21
PCMIn
PCMOut
PCMClk
PCMSync
UARTRx
UARTTx
UARTCTS
UARTRTS
VBAT
VIO
BT_ResetX
UART_WakeUp
BT WakeUp
PURX
SleepCLK
BT CLK_REQ
WLAN CLK_REQ
BTHFMRDS2.0D
WLAN_TX_CONFX
WLAN_RF_ACTIVE

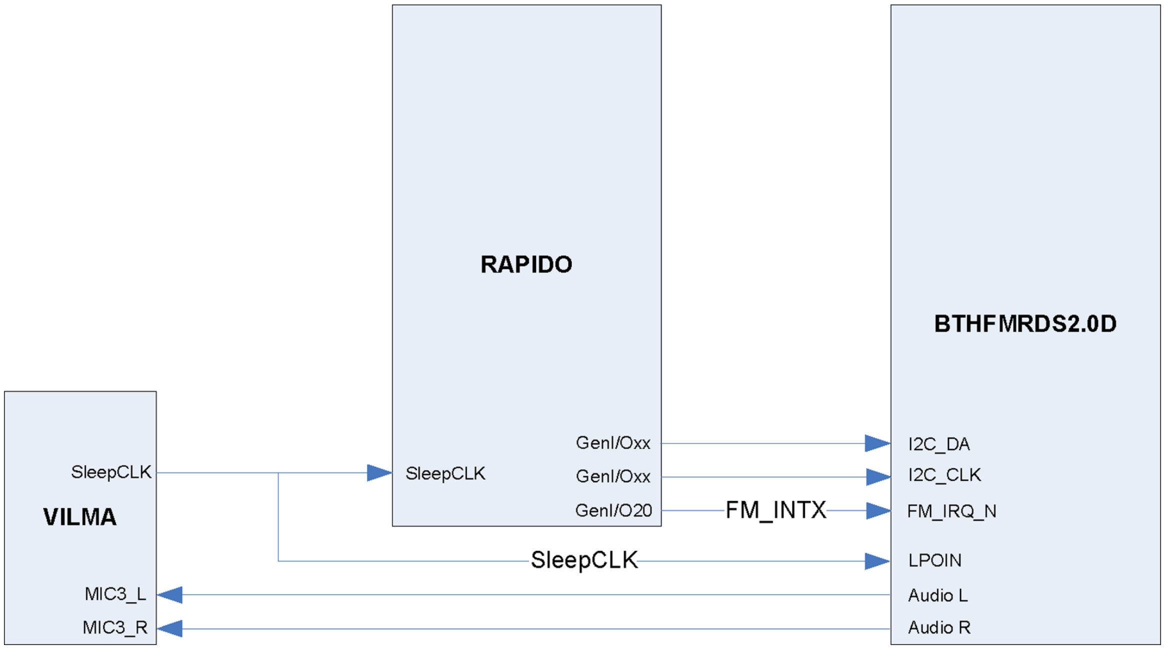
WLAN

A Wireless Local Area Network (WLAN) is a flexible data communication system in which a mobile user can connect to a local area network through a wireless connection. The standard, which specifies the technologies for WLAN, is called IEEE 802.11. The device supports both IEEE 802.11b and 802.11g standards, so the supported data rates are from 1 Mbps to 54 Mbps in 2.4 GHz ISM band.

WLAN ASIC is powered by VBAT. VIO is required for SPI which connects WLAN ASIC to host processor. WLAN requires 38.4 MHz reference clock which is taken from RF VCTCXO via BT/WLAN clock buffer. WLAN shares the same antenna with BT and common RF path is shared according to the coexistence signaling between the ASICs.


38.4MHz RF CLK
BT and WLAN SYS CLK
to/from BT
TX_CONFX
RF_ACTIVE
STATUS
FREQ
VBAT
VIO
BETTY
SleepX
RAPIDO
SleepX
GenI/O72
GenI/O63
GenI/O43
GenI/O73
SPI_CLK
SPI_DIN
SPI_DOUT
SPI_CSX
WLAN
CBUS
SleepX
SleepCLK
VILMA
SleepX
SleepCLK
APE_SleepX
GenI/O29
GenI/O54
HOST_IRQ
WLAN_ENABLE
SleepCLK
WLAN CLK_REQ
BT CLK_REQ

FM radio


RAPIDO
BTHFMRDS2.0D
GenI/Oxx
GenI/Oxx
GenI/O20
SleepCLK
I2C_DA
I2C_CLK
FM_IRQ_N
FM_INTX
VILMA
SleepCLK
SleepCLK
LPOIN
MIC3_L
MIC3_R
Audio L
Audio R

The FM radio is an integrated circuit, controlled by MCU software through a serial bus interface. The wires of the headset are used as elements of the antenna, and no other antenna is needed for FM radio reception.

The FM radio is provided with LDO (low drop out) voltage VAUX 2.78V.

The radio has an automatic band search function, which can search for a strong station.

USB

USB (Universal Serial Bus) provides a wired connectivity between a PC and peripheral devices. It is a differential serial bus.

USB 2.0 is supported with full speed (12 Mbps).

Hot swap is supported, which means that USB devices may be plugged in/out at any time.

This phone is provided with a specific connector for micro USB.

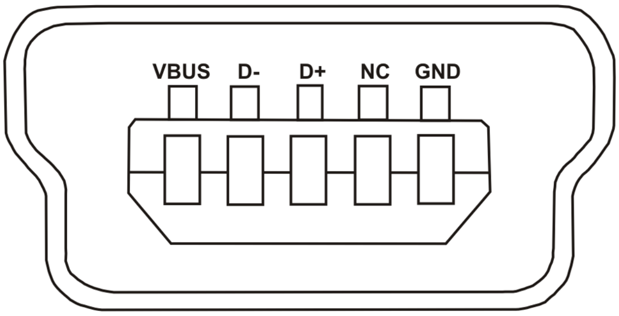


Figure 50 Micro USB Connector

CBUS interface

CBUS is a "main" system control bus in BB5. RAPIDO controls the functionality of EM ASIC (N2200) and EM ASIC (N2300) ASICs with CBUS.

CBUS is a four-wire half-duplex master-slave interface. In BB5 CBUS clock frequency is 2.4 MHz.

FBUS

USB and FBUS have multiplexed interface between EM ASIC (2300) and RAPIDO.

ECI interface

The ECI (Enhancement Control Interface) is a point-to-point, bi-directional, single line serial bus.

The purpose of the ECI is to identify and authenticate the accessory, and to act as a data bus (intended for control purposes) between the phone and the accessory .

Charger interface

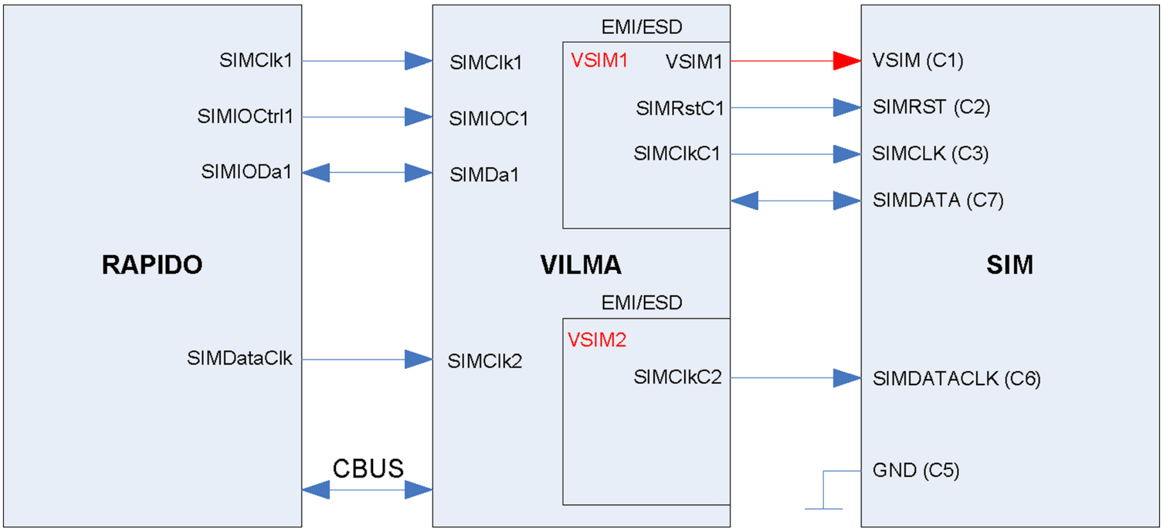
Charging control and charge switch are situated in EM ASIC (N2300).

If the temperature rises too high and the thermal protection is activated, EM ASIC (N2300) goes to protection mode.

SIM interface

The device has one SIM (Subscriber Identification Module) interface. It is only accessible if battery is removed. The SIM interface consists of an internal interface between RAPIDO and EM ASIC (N2200), and of an external interface between N2200 and SIM contacts.

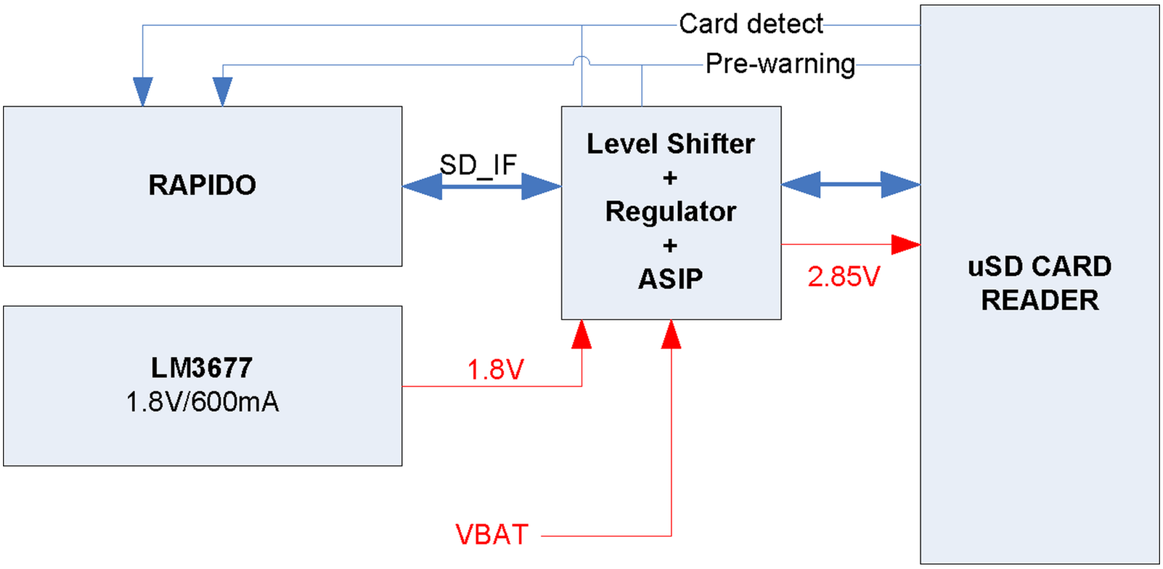
The SIM IF is shown in the following figure:


RAPIDO
SIMClk1
SIMIOCtrl1
SIMIODa1
SIMDataClk
CBUS
VILMA
SIMClk1
SIMIOC1
SIMDa1
SIMClk2
EMI/ESD
VSIM1
VSIM1
SIMRstC1
SIMClkC1
EMI/ESD
VSIM2
SIMClkC2
SIM
VSIM (C1)
SIMRST (C2)
SIMCLK (C3)
SIMDATA (C7)
SIMDATACLK (C6)
GND (C5)

The EM ASIC handles the detection of the SIM card. The detection method is based in the BSI line. Because of the location of the SIM card, removing the battery causes a quick power down of the SIM IF.

The EM ASIC SIM1 interface supports both 1.8 V and 3.0 V SIM cards. The SIM interface voltage is first 1.8 V when the SIM card is inserted, and if the card does not response to the ATR a 3 V interface voltage is used.

µSD card interface


Card detect
Pre-warning
RAPIDO
SD_IF
Level Shifter + Regulator + ASIP
uSD CARD READER
2.85V
LM3677 1.8V/600mA
1.8V
VBAT

The µSD card is connected to the engine by an external level shifter with an ESD protection filter. Supplied voltages:

- VSD: 2.85 V (from level shifter)
- VIO: 1.8 V (from AVILMA)

The uSD card reader has two switches: card_detection and pre_warning. This enables hot swapping, which means that the card may be plugged in/out at any time, without removing the battery.

Camera

Camera characteristics

Sensor type	CMOS
Sensor photo detectors	2 Million (1600 x 1200 pixels)
F number/Aperture	f/2.8
Focal length	4.4mm
Focus range	40cm to infinity
Still Image resolutions	1600x1200, 1152x862, 640x480, 320x240
Still images file format	EXIF (JPEG), *.jpg
Video resolutions	320 x 240, 176 x 144
Video clip length	30 sec short mode or 1 hour free mode
Video file format	3GPP (*.3gp), MPEG-4 (*.mp4)
Exposure control	
Automatic balance	Automatic, sunny, incandescent, fluorescent
Colour tones	Normal, sepia, black&white, negative
Capture Modes	Still capture mode, video mode and sequence mode
Selftimer	10s, 20s, 30s
Flash settings	Auto, off and forced

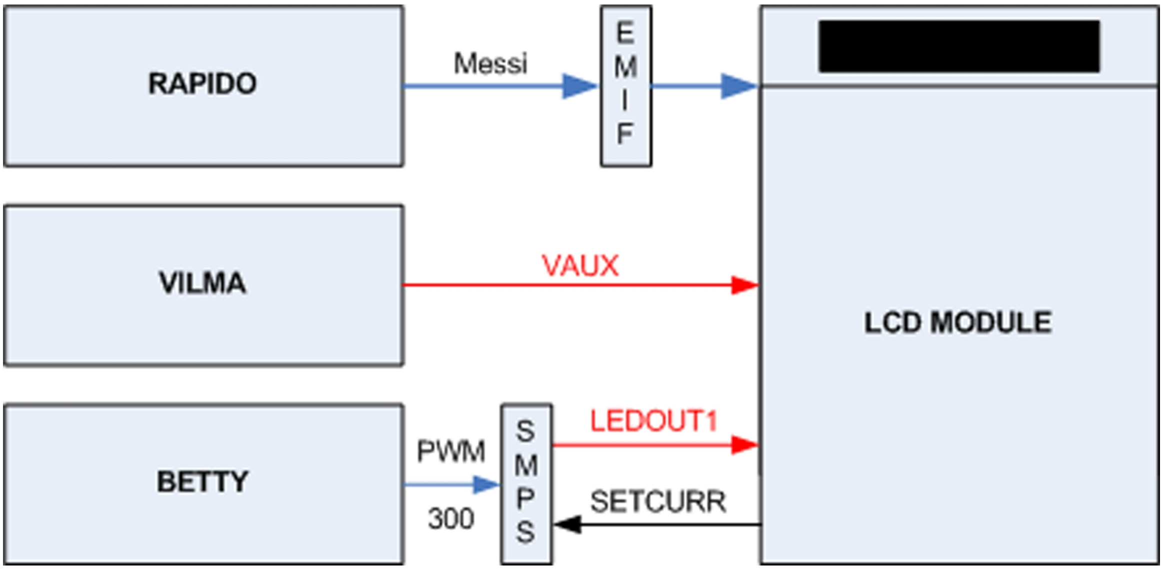
User interface

Display module

Display module

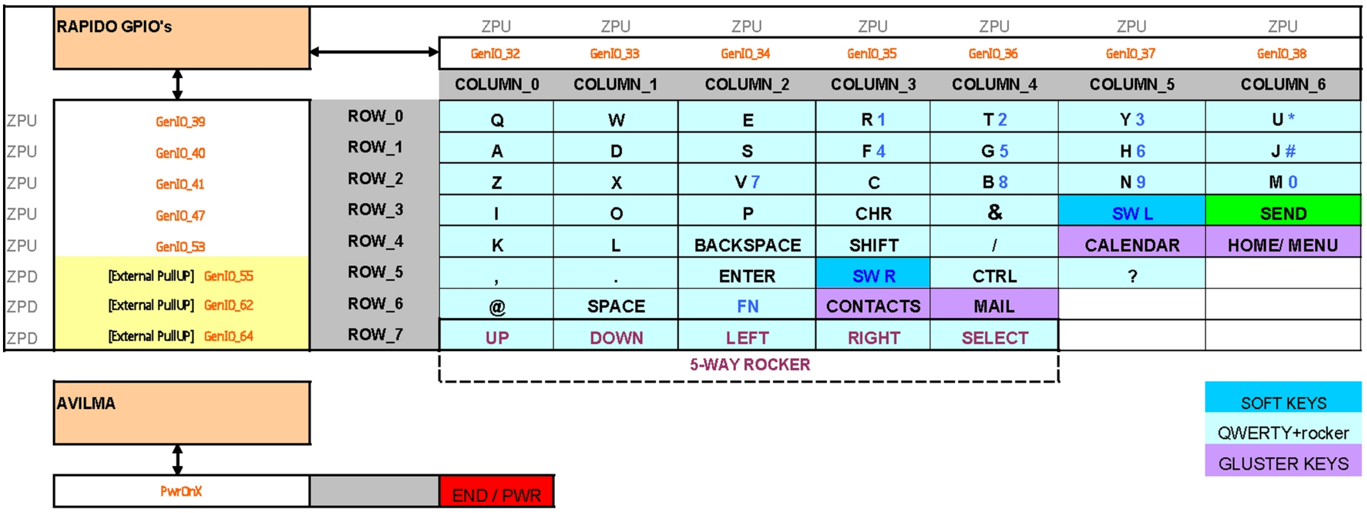
- Active TFT QVGA display supports up to 16,777,216 colors (320 x 240 pixels, 2.4 inches)

The interconnection between the LCD module and the engine is implemented with a 24-pin board-to-board connector.

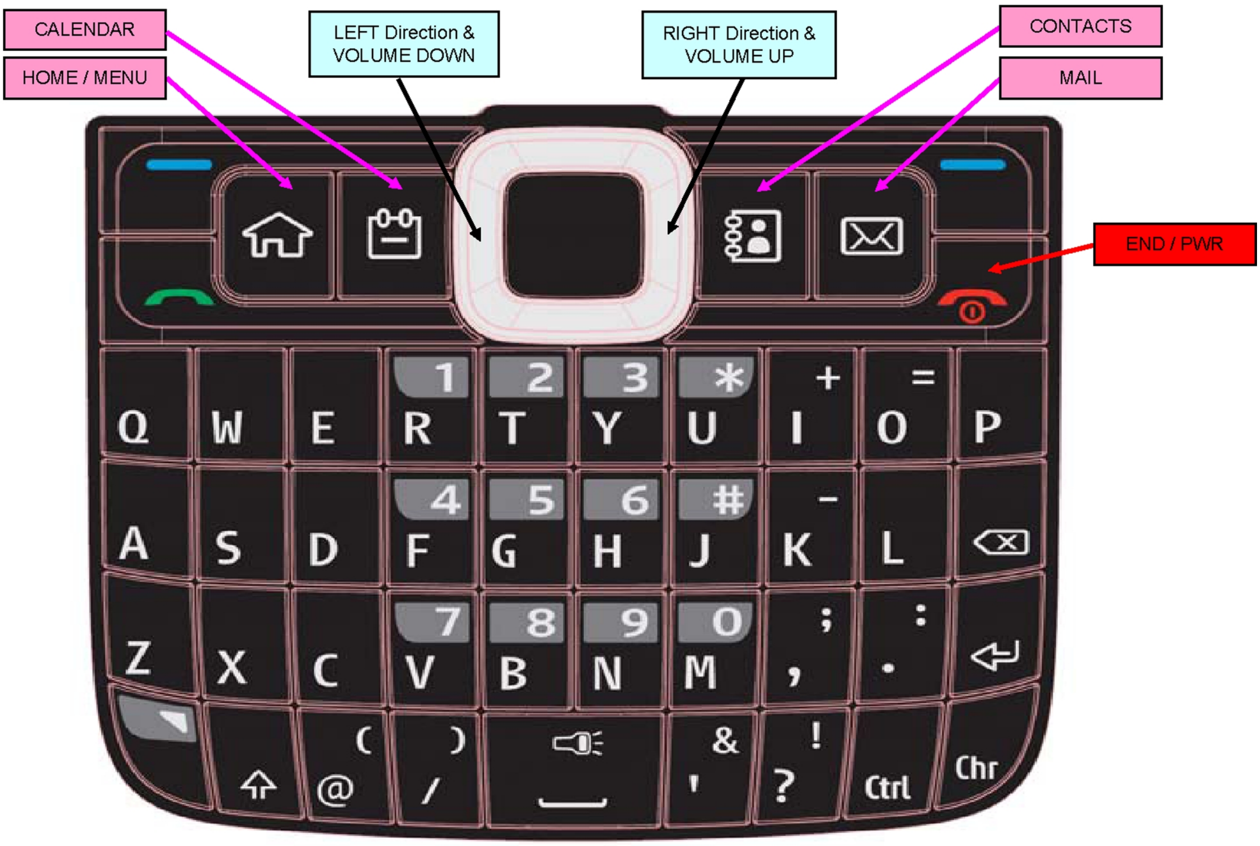

RAPIDO
Messi
EMIF
[redacted]
VILMA
VAUX
LCD MODULE
BETTY
PWM
300
SMPS
LEDOUT1
SETCURR

Keyboard

The QWERTY keyboard is placed on the top of the chassis. End key is combined END /Power key (connected to PWRONX). All keys are connected to same keymatrix made by the RAPIDO genios (except End/Power on key).

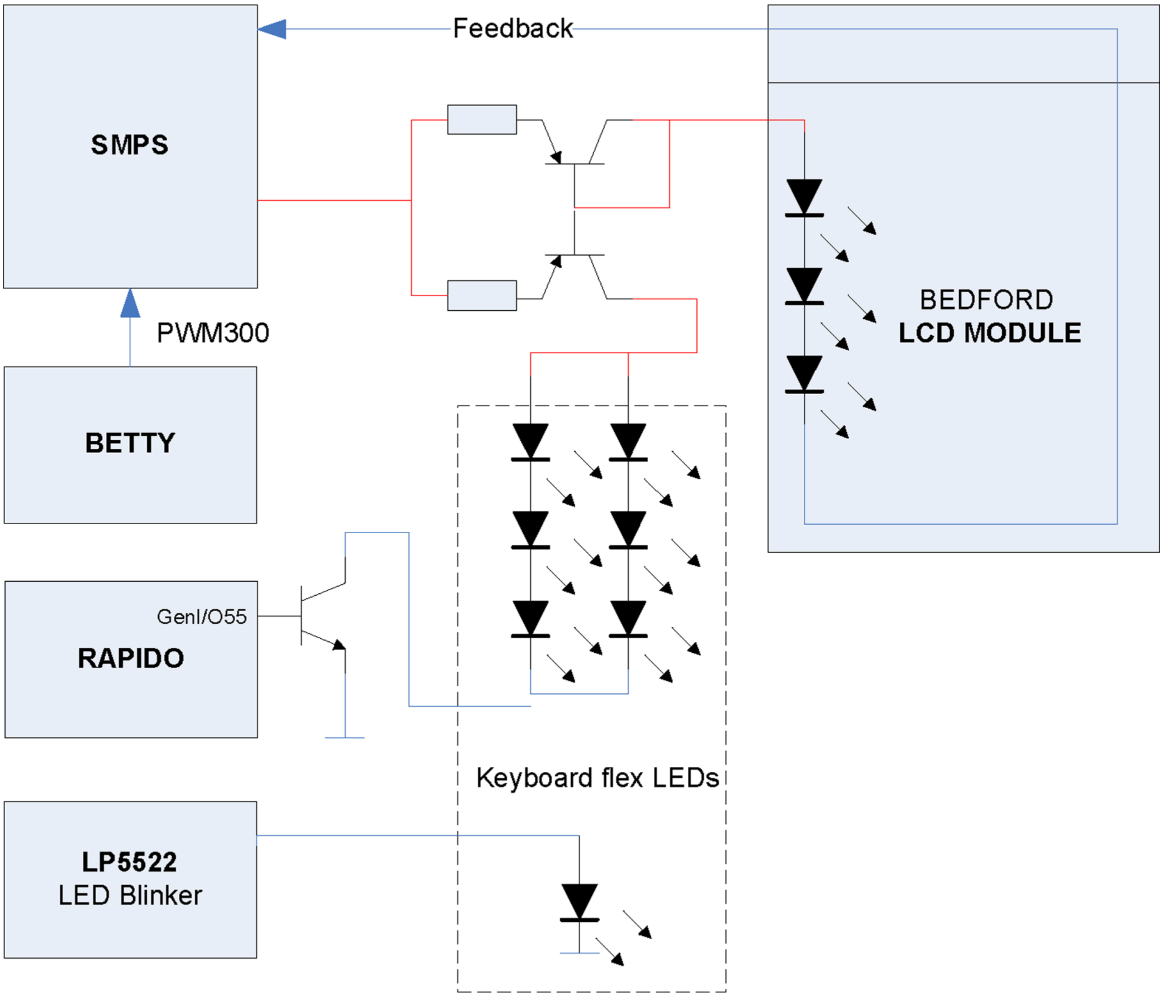

RAPIDO GPIO's
AVILMA
PwrOnX
END / PWR
5-WAY ROCKER
SOFT KEYS
QWERTY+rocker
GLUSTER KEYS

			ZPU	ZPU	ZPU	ZPU	ZPU	ZPU	ZPU
			GenIO_32	GenIO_33	GenIO_34	GenIO_35	GenIO_36	GenIO_37	GenIO_38
			COLUMN_0	COLUMN_1	COLUMN_2	COLUMN_3	COLUMN_4	COLUMN_5	COLUMN_6
ZPU	GenIO_39	ROW_0	Q	W	E	R 1	T 2	Y 3	U *
ZPU	GenIO_40	ROW_1	A	D	S	F 4	G 5	H 6	J #
ZPU	GenIO_41	ROW_2	Z	X	V 7	C	B 8	N 9	M 0
ZPU	GenIO_47	ROW_3	I	O	P	CHR	&	SW L	SEND
ZPU	GenIO_53	ROW_4	K	L	BACKSPACE	SHIFT	/	CALENDAR	HOME/ MENU
ZPD	[External PullUP] GenIO_55	ROW_5	,	.	ENTER	SW R	CTRL	?	
ZPD	[External PullUP] GenIO_62	ROW_6	@	SPACE	FN	CONTACTS	MAIL		
ZPD	[External PullUP] GenIO_64	ROW_7	UP	DOWN	LEFT	RIGHT	SELECT		


CALENDAR
HOME / MENU
LEFT Direction & VOLUME DOWN
RIGHT Direction & VOLUME UP
CONTACTS
MAIL
END / PWR

Backlight and illumination

There is backlight illuminating the display, upper keypad and lower keypad.


Feedback
SMPS
PWM300
BETTY
GenI/O55
RAPIDO
BEDFORD
LCD MODULE
Keyboard flex LEDs
LP5522
LED Blinker

ASICs

RAPIDO

RAPIDO is multimode 2G/3G baseband ASIC. Main features and blocks of the RAPIDO:

- ARM1136 MCU as a main processor
- Level 2 cache (256 kbytes) added for ARM1136
- UMA 2.5 DSP megacell including larger DSP internal memories
- 3G System logic
- 2G System logic
- 16bit NOR Flash interface (MCU speed/4, Flash memory max 66 MHz)
- 16-bit Muxed Mass Memory (M3) Flash interface
- 16 bit / 32 bit DDR SDRAM interface
- NAND Flash interface - High speed MMC (4-bit bus)/ SD interface
- GPIOs for keyboard/roller/rocker
- LoSSI serial interface for display
- 2 pcs 8-bit or 16-bit MeSSI parallel interfaces for display
- VISSI up to 24-bit parallel video display interface with internal display controller
- High speed USB 2.0 with On-The-Go controller with ULPI transceiver interface

- ACI accessory interface
- AD/DA conversion functions for WCDMA/GSM
- FBUS(ASI) support
- CBUS and RFBUS for system control
-
- New block added to provide HW acceleration for Edge
- Rxmodem block added for AMPS mode
- 2 pcs Camera RX data interfaces: CCP2 (416 Mb/s) and CCP(208 Mb/s)
- One SIM interface with new SIMIF block called SIMo
- I2C for controlling additional peripherals (no system control)
- SPI's having audio transfer capability (I2S and PCM) - PDM/PWM audio interfaces to Vilma
- IrDA interface (SIR, MIR and FIR -4 Mbit)
- CMT-APE(SSI) interface (to APE)
- ETM, XTI and JTAG trace interfaces

BETTY N2300

BETTY Power IC is intended for energy management control, supply voltage generation and charge control of mobile phone. It has following blocks:

- Vcore Smartflex support. 8 level SW programmable (1.05, 1.15, 1.2, 1.25, 1.3, 1.35, 1.4, 1.45V) SMPS for digital core supply generation max 400 mA output current, this regulator can be disabled (regulator is disabled in BB5.4X engine)
- Charge control circuitry with integrated switch
- Level shifters and regulator for FBUS/USB
- Current gauge for measuring current from/to battery
- Digital circuitry for controlling through CBUS
- 5 General outputs controlled via CBUS
- White LED driver (is not used in BB5.4 because of some restrictions in functionality)

VILMA N2200

VILMA is a module containing an energy management ASIC with some audio functions stacked with ASIP. The content of VILMA ASIP is described in the VILMA ASIP Specification. VILMA ASIC consists of following blocks:

- Startup logic & reset control
- Charger detection
- Battery voltage monitor
- 32,768 Hz clock with external crystal
- Bandgap reference and 1.350 V reference voltage output
- Linear regulator (2.5V) for VCTCXO in RF
- 5V+ charge pump and linear regulator (4.75V) for RF
- Two linear regulators (3.0/1.8V) for SIM & smart cards
- 1.8 V regulator for RF converters
- 1.8 V regulator for I/O (VIO)
- 1.8 V regulator for DRAM (VDRAM)

- 2.5/2.78 V programmable regulator for BB
- 2.5 V regulator for BB
- Digital control interfaces
- Real time clock with external backup battery
- Two SIM card interfaces
- Stereo audio codecs and amplifiers
- Two DACs for AFC and TxC
- 12-channel "slow" A/D converter
- S/H circuit for VBATT A/D channel
- Buzzer and vibrator drivers
- DPMA driver (H-bridge)
- ECI and AV interface support

EMC ASIP (Appcation Specified Integrated Passive) have been integrated inside the ASIC. It includes biasing passives for microphone , EMC filter for SIM, microphones etc.

Device memories

Combo memory

The application memory of the device consists of NAND/DDR combo memory. The stacked DDR/NAND application memory has 1Gbit of DDR memory and 2 Gbit of flash memory.

Audio concept

Audio HW architecture

The functional core of the audio hardware is built around two ASICs: RAPIDO engine ASIC and the mixed signal ASIC Avilma.

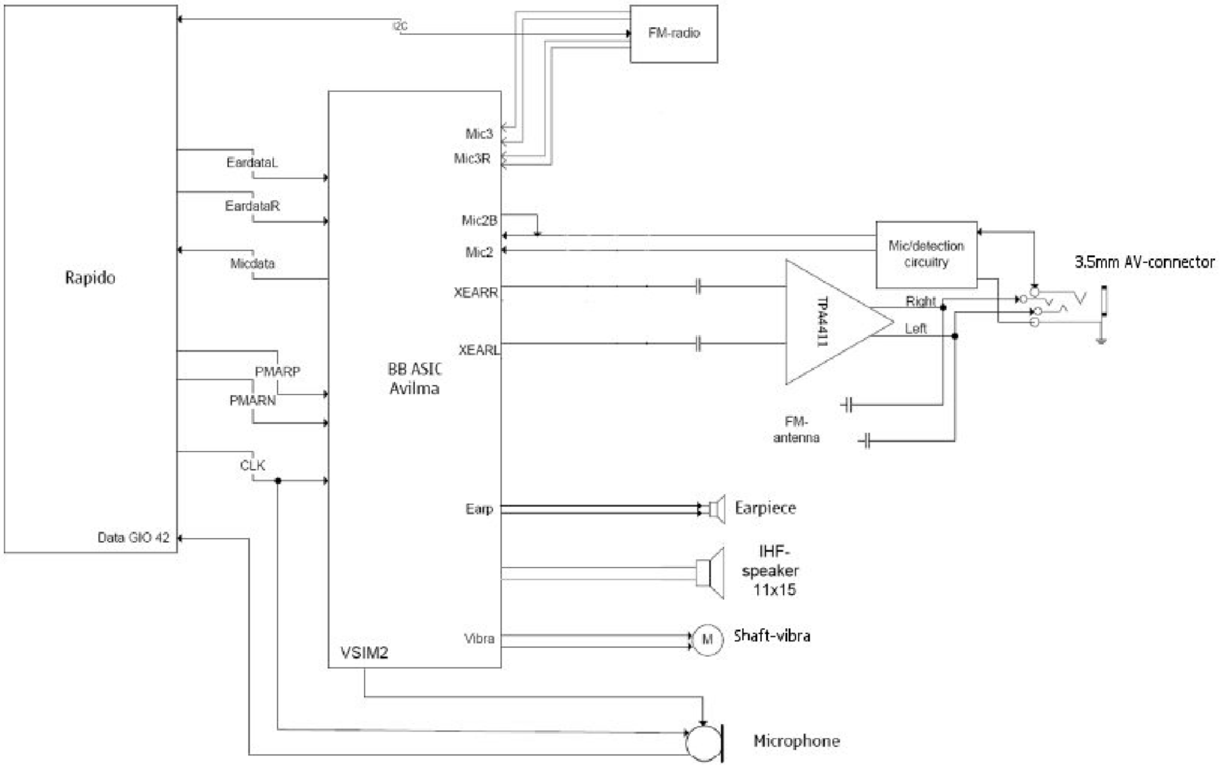
Avilma provides an interface for the transducers and the accessory connector. There are four audio transducers:

- 4.8x10 mm dynamic earpiece
- 11x15 mm dynamic speaker
- Digital MEMS (microelectromechanical systems) microphone

In addition to the audio transducers, Avilma also provides an output for the dynamic vibra component.

All galvanic audio accessories are connected to the AV accessory connector.

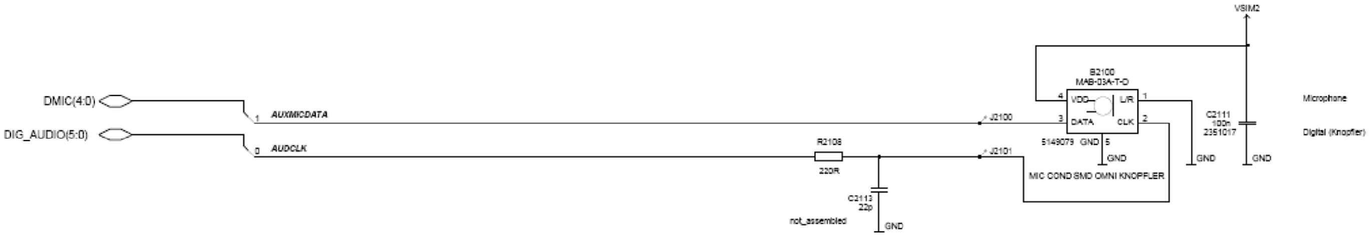
A Bluetooth audio and FM radio module, which is connected to the RAPIDO ASIC supports Bluetooth audio and FM radio functionality.


Rapido
I2C
FM-radio
EardataL
EardataR
Micdata
PMARP
PMARN
CLK
Data GIO 42
BB ASIC
Avilma
Mic3
Mic3R
Mic2B
Mic2
XEARR
XEARL
Earp
Vibra
VSIM2
Mic/detection
circuitry
TPA4411
Right
Left
3.5mm AV-connector
FM-
antenna
Earpiece
IHF-
speaker
11x15
M
Shaft-vibra
Microphone

Internal microphone

The internal microphone is used for HandPortable (HP) and Internal HandsFree (IHF) call modes.

A digital MEMS microphone data and clock line are connected to Rapido ASIC while power supply is received from Avilma.

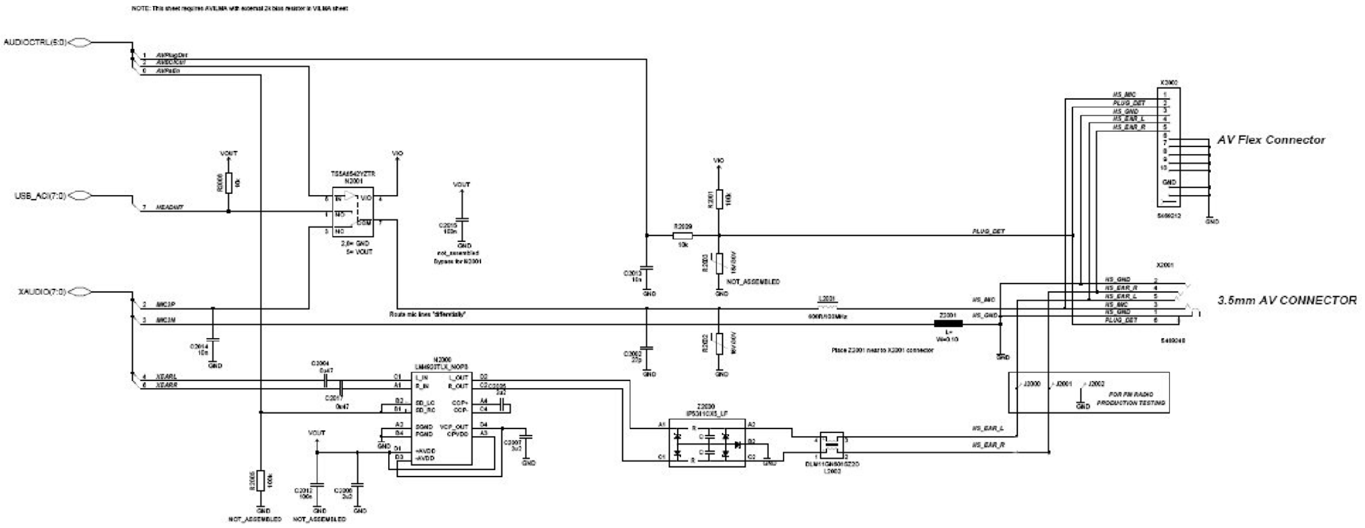

VSIM2
DMIC(4:0)
DIG_AUDIO(5:0)
1
AUXMICDATA
0
AUDCLK
R2108
220R
C2113
22p
not_assembled
GND
J2100
J2101
B2100
MAB-03A-T-D
4
VDD
L/R
1
3
DATA
CLK
2
5149079
GND
5
GND
MIC COND SMD OMNI KNOPFLER
C2111
100n
2351017
GND
GND
Microphone
Digital (Knopfler)

External microphone and earpiece

Galvanic accessories are connected to the AV connector. Accessory audio mode is automatically enabled / disabled during connection/disconnection of dedicated phone accessories.

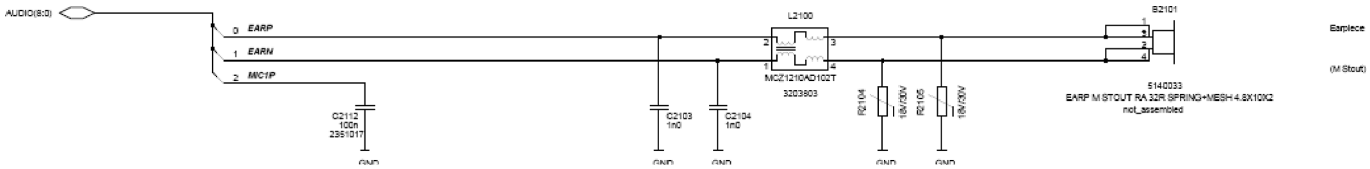
External microphone circuitry is biased by Avilma ASIC MicB2 bias voltage output. The circuitry provides an asymmetrical connection for the microphone from the AV connector, XMICP to Avilma ASIC input, mic2p and XMICN, to GND.

The Avilma ASIC provides two output channels in either single-ended or differential format. The Avilma ASIC outputs XearL and XearLC form the left channel audio output and XearR and XearRC the right channel audio output. XearLC and XearRC are the ground pins if the output works in a single-ended operation.


NOTE: This sheet requires AVILMA with external 2k bias resistor in VILMA sheet
AUDIOCTRL(5:0)
USB_ACI(7:0)
XAUDIO(7:0)
TS5A6542YZTR
N2001
N2000
LM4920TLX_NOPB
VOUT
VIO
R2029
10k
PLUG_DET
Route mic lines "differentially"
L2031
Z2001
Place Z2001 near to X2001 connector
Z2030
IP5310CX5_LF
DLM11GN601SZ20
L2002
FOR FM RADIO PRODUCTION TESTING
J2000
J2001
J2002
X2000
AV Flex Connector
X2001
3.5mm AV CONNECTOR
NOT_ASSEMBLED
GND

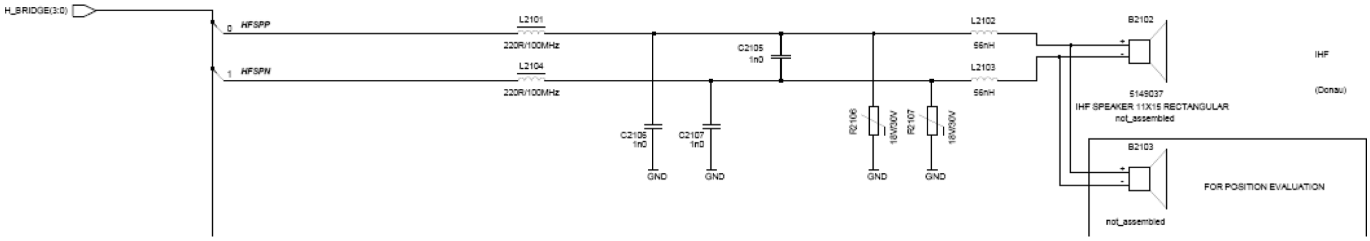
Internal earpiece

Internal earpiece is used for the HandPortable (HP) call mode. A dynamic 4.8 x 10 mm earpiece capsule is connected to Avilma ASIC's differential output EarP and EarN.


AUDIO(8:0)
0 EARP
1 EARN
2 MIC1P
C2112
100n
2351017
C2103
1n0
C2104
1n0
L2100
MCZ1210AD102T
3203803
R2104
18V/30V
R2105
18V/30V
B2101
Earpiece
(M Stout)
5140033
EARP M STOUT RA 32R SPRING+MESH 4.8X10X2
not_assembled
GND

Internal speakers

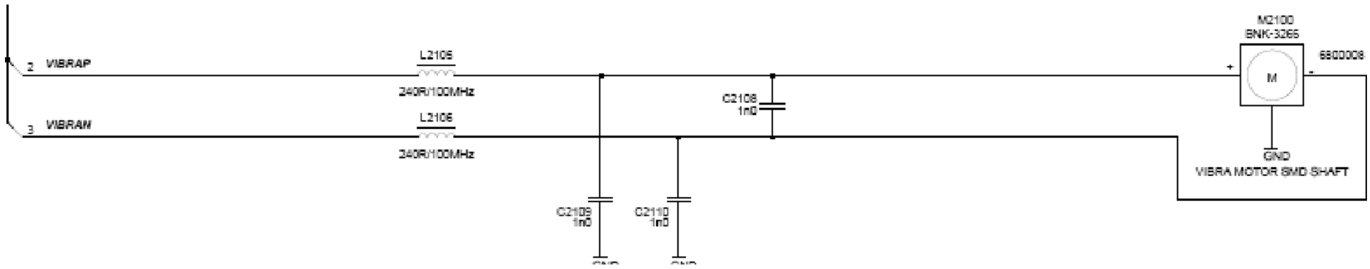
Internal speaker is used for Internal HandsFree (IHF) call mode, video call, ringing tones, FM radio and music listening. Dynamic 11x15mm speaker is connected to Avilma ASIC's outputs HFSpP and HFSpN.


H_BRIDGE(3:0)
0 HFSPP
1 HFSPN
L2101
220R/100MHz
L2104
220R/100MHz
C2106
1n0
C2107
1n0
C2105
1n0
R2106
18V/30V
R2107
18V/30V
L2102
56nH
L2103
56nH
B2102
IHF
(Donau)
5149037
IHF SPEAKER 11X15 RECTANGULAR
not_assembled
B2103
FOR POSITION EVALUATION
not_assembled
GND

Vibra circuitry

Vibra is used for the vibra alarm function.

The vibra motor is connected to the Avilma ASIC VibraP and VibraN Pulse Width Modulated (PWM) outputs.


2 VIBRAP
3 VIBRAN
L2105
240R/100MHz
L2106
240R/100MHz
C2108
1n0
C2109
1n0
C2110
1n0
M2100
BNK-3266
6800008
M
GND
VIBRA MOTOR SMD SHAFT

AV connector

The AV connector consists of single ended mono or stereo audio output and mono audio input.

The handsfree driver in Avilma is meant for the headset.

Table 15 AV interface electrical characteristics

Signal name	Function/ Parameter	Min	Typ	Max	Unit	Notes
HSMIC	HS mic audio input	-	-	1.3 V_{pp}	V	Max. negative level - 0.7 V
HSEARL	HS EAR L audio output	-	-	2 V_{pp}	V	SPR requirement
HSEARR	HS EAR R audio output	-	-	2 V_{pp}	V	SPR requirement
MICBIAS	HS MIC bias voltage	2.05	2.1	2.25	V	
ECI	Vin high	1.7	-	2.6	V	
ECI	Vin low	0	-	0.7	V	

Baseband technical specifications

External interfaces

Name of Connection	Connector reference
USB	X3300 (on engine PWB)
Charger	X2000 (on engine PWB)
Headset	X2002 (on AV flex)
SIM	X2700 (on engine PWB)
Micro SD	X3200 (on engine PWB)
Battery connector	X2070 (on engine PWB)

SIM IF connections

Pin	Signal	I/O	Engine connection		Notes
C1	VSIM	Out	EM ASIC N2200	VSIM1	Supply voltage to SIM card, 1.8V or 3.0V.
C2	SIMRST	Out	EM ASIC N2200	SIM1Rst	Reset signal to SIM card
C3	SIMCLK	Out	EM ASIC N2200	SIM1ClkC	Clock signal to SIM card
C5	GND	-	GND		Ground

Pin	Signal	I/O	Engine connection		Notes
C7	SIMDATA	In/Out	EM ASIC N2200	SIM1DaC	Data input / output
SW	SIM_DET	In	EM ASIC N2200	SIMDetX	Removal detection

Charger connector and charging interface connections & electrical characteristics

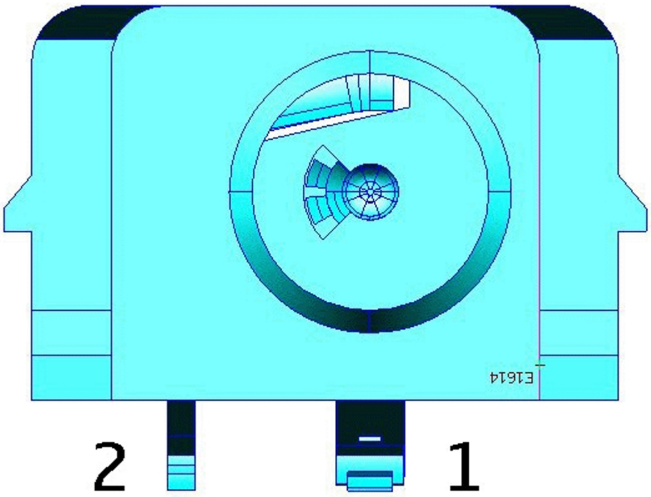


Figure 51 Charger connector

Table 16 Charging interface connections

Pin	Signal	I/O	Engine connection		Notes
1	Vchar	In	N2300	VCharIn1, 2	Charging voltage / charger detection, Center pin
2	Charge GND		Ground		Charger ground

Table 17 Charging IF electrical characteristics

Description	Parameter	Min	Max	Unit	Notes
Vchar	V Charge	0	9	V	Center pin
Vchar	I Charge		0.85	A	Center pin
Charge GND			0.85	A	

Internal interfaces

Name of Connection	Connector reference
ALS	V2500

Name of Connection	Connector reference
Display	X2400
Earpiece	B2101
UI flex connector	X2400
AV flex connector	X2002
IHF speaker	B2102
Camera	X1550
Microphone	B2100
Vibra	M2100

Back-up battery interface electrical characteristics

Table 18 Back-up battery connections

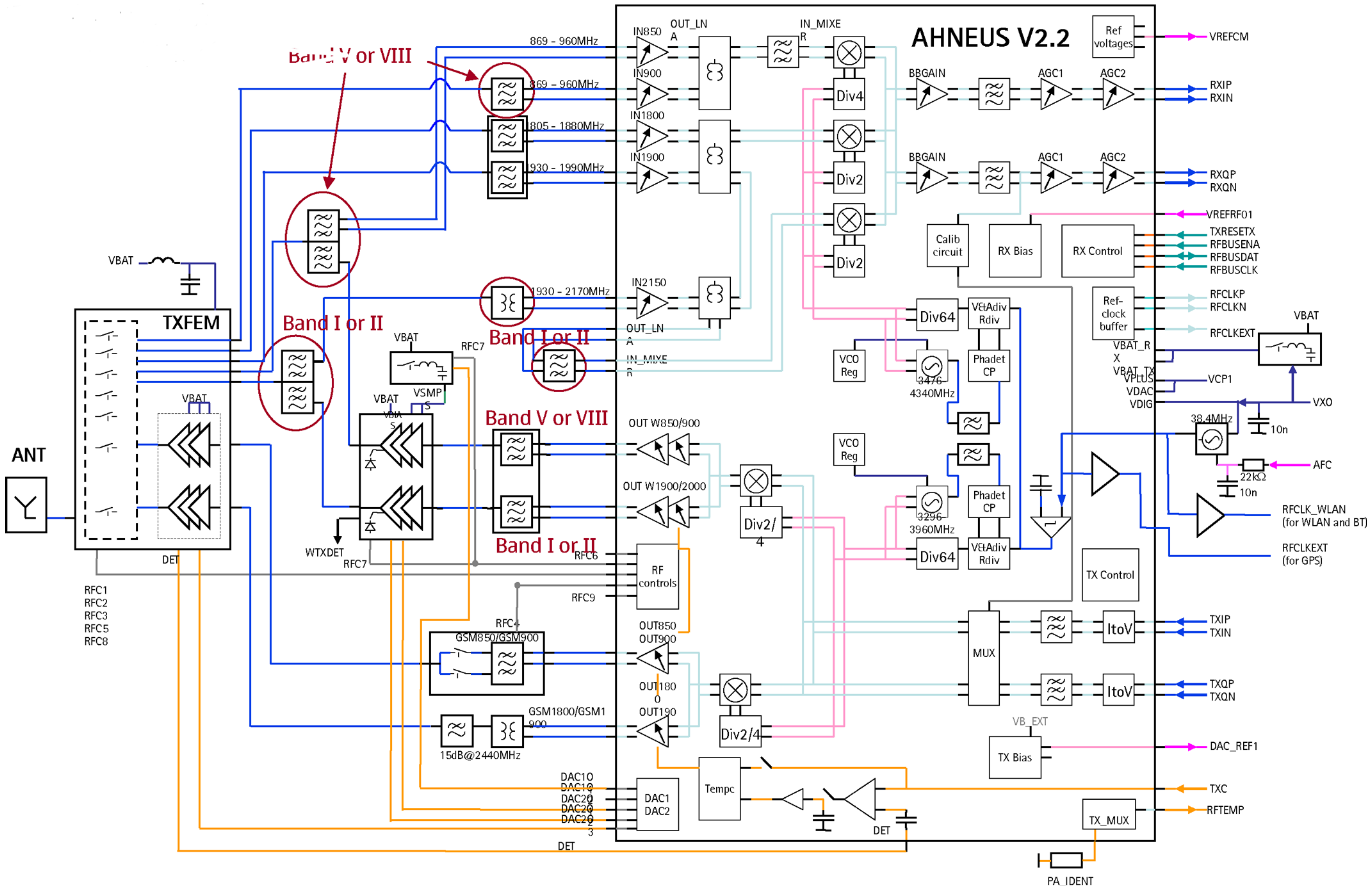
Pin name	I/O	Connection	Notes
L2207, VBack	->	N2200, VBack	Back-up battery G2200 is connected to N2200 via coil

Table 19 Back-up battery electrical characteristics

Description	Parameter	Min	Typ	Max	Unit
Back-Up Battery Voltage	Vback	0	2.5	2.7	V

RF description

Block diagram


AHNEUS V2.2
Band V or VIII
Band I or II
TXFEM
ANT
VBAT
869 - 960MHz
1805 - 1880MHz
1930 - 1990MHz
1930 - 2170MHz
RXIP
RXIN
RXQP
RXQN
TXIP
TXIN
TXQP
TXQN
VREFCM
RFCLKP
RFCLKN
AFC
PA_IDENT

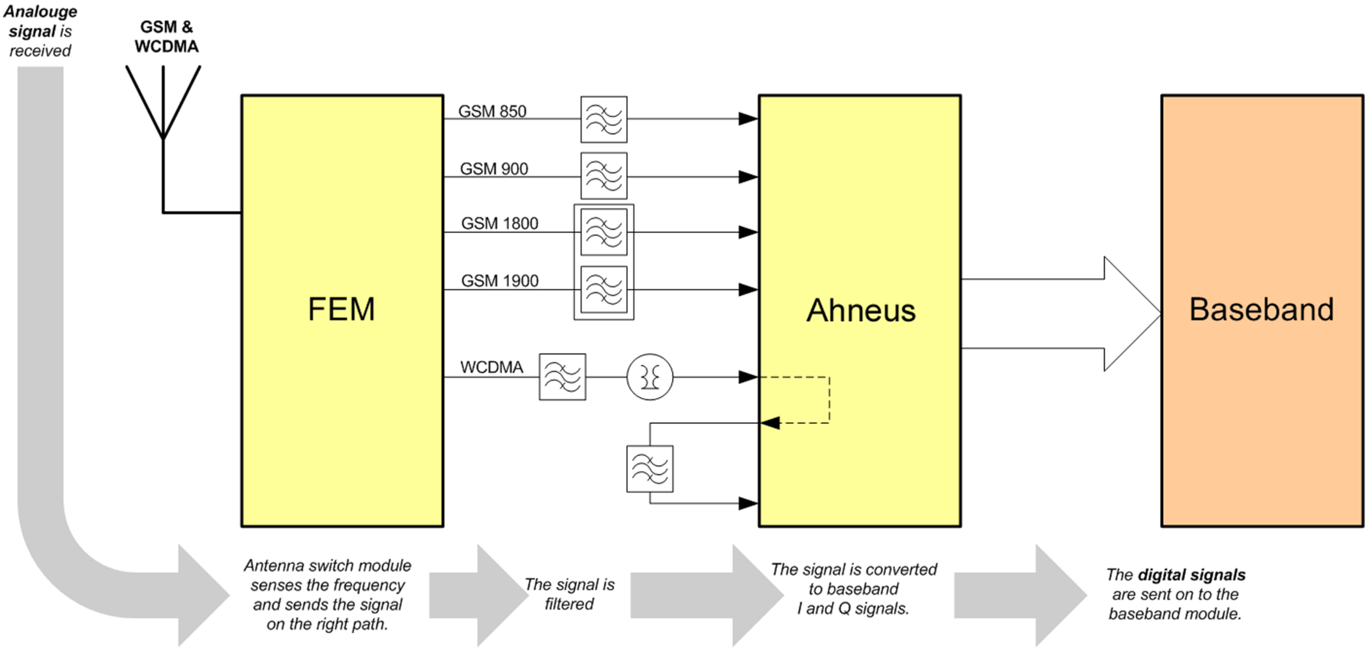
The RF block diagram for RM-437 uses RF ASIC N7505 that performs the RF back-end functions of receive and transmit function of the cellular transceiver.

Receiver (RX)

An analogue signal is received by the phone's antenna. The signal is converted to a digital signal and is then transferred further to the baseband (eg. to the earpiece).

The receiver functions are implemented in the RF ASIC.

Signals with different frequencies take different routes, being handled by different components. The principle of GSM and WCDMA is the same.

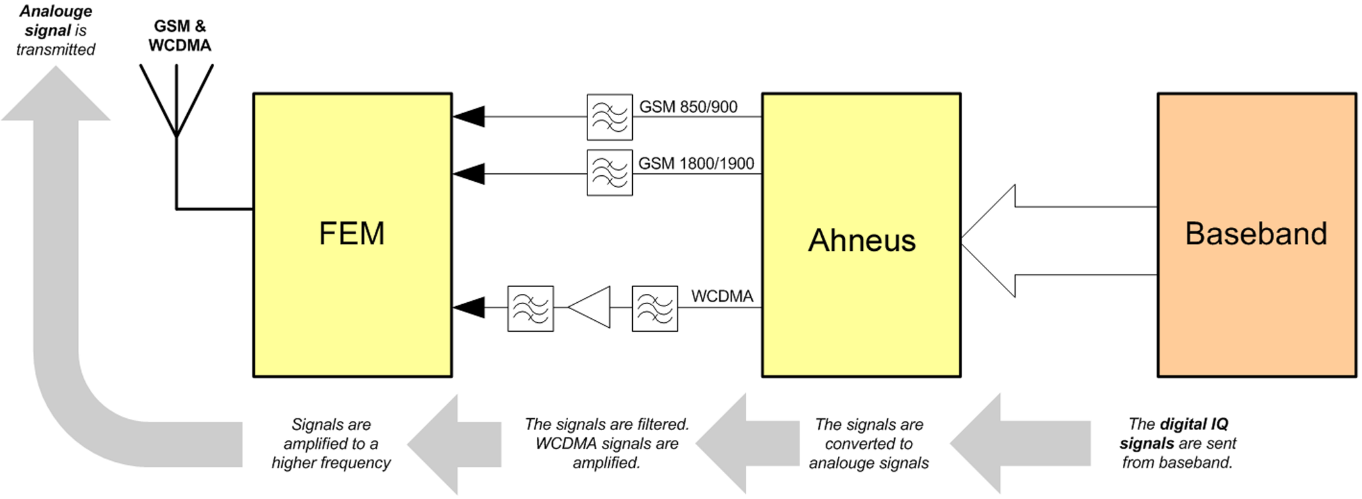

Analouge signal is received
GSM & WCDMA
FEM
GSM 850
GSM 900
GSM 1800
GSM 1900
WCDMA
Ahneus
Baseband
Antenna switch module senses the frequency and sends the signal on the right path.
The signal is filtered
The signal is converted to baseband I and Q signals.
The digital signals are sent on to the baseband module.

Transmitter (TX)

The digital baseband signal (eg. from the microphone) is converted to an analogue signal, which is then amplified and transmitted from the antenna. The frequency of this signal can be tuned to match the bandwidth of the system in use (eg. GSM900).

The transmitter functions are implemented in the RF ASIC.

Even though the GSM and WCDMA signals pass different components, the principles of the transmission is the same.


Analouge signal is transmitted
GSM & WCDMA
FEM
GSM 850/900
GSM 1800/1900
WCDMA
Ahneus
Baseband
Signals are amplified to a higher frequency
The signals are filtered. WCDMA signals are amplified.
The signals are converted to analouge signals
The digital IQ signals are sent from baseband.

Frequency mappings

GSM850 frequencies

CH	TX	RX	VCO TX	VCO RX	CH	TX	RX	VCO TX	VCO RX	CH	TX	RX	VCO TX	VCO RX
128	824.2	869.2	3296.8	3476.8	170	832.6	877.6	3330.4	3510.4	212	841.0	886.0	3364.0	3544.0
129	824.4	869.4	3297.6	3477.6	171	832.8	877.8	3331.2	3511.2	213	841.2	886.2	3364.8	3544.8
130	824.6	869.6	3298.4	3478.4	172	833.0	878.0	3332.0	3512.0	214	841.4	886.4	3365.6	3545.6
131	824.8	869.8	3299.2	3479.2	173	833.2	878.2	3332.8	3512.8	215	841.6	886.6	3366.4	3546.4
132	825.0	870.0	3300.0	3480.0	174	833.4	878.4	3333.6	3513.6	216	841.8	886.8	3367.2	3547.2
133	825.2	870.2	3300.8	3480.8	175	833.6	878.6	3334.4	3514.4	217	842.0	887.0	3368.0	3548.0
134	825.4	870.4	3301.6	3481.6	176	833.8	878.8	3335.2	3515.2	218	842.2	887.2	3368.8	3548.8
135	825.6	870.6	3302.4	3482.4	177	834.0	879.0	3336.0	3516.0	219	842.4	887.4	3369.6	3549.6
136	825.8	870.8	3303.2	3483.2	178	834.2	879.2	3336.8	3516.8	220	842.6	887.6	3370.4	3550.4
137	826.0	871.0	3304.0	3484.0	179	834.4	879.4	3337.6	3517.6	221	842.8	887.8	3371.2	3551.2
138	826.2	871.2	3304.8	3484.8	180	834.6	879.6	3338.4	3518.4	222	843.0	888.0	3372.0	3552.0
139	826.4	871.4	3305.6	3485.6	181	834.8	879.8	3339.2	3519.2	223	843.2	888.2	3372.8	3552.8
140	826.6	871.6	3306.4	3486.4	182	835.0	880.0	3340.0	3520.0	224	843.4	888.4	3373.6	3553.6
141	826.8	871.8	3307.2	3487.2	183	835.2	880.2	3340.8	3520.8	225	843.6	888.6	3374.4	3554.4
142	827.0	872.0	3308.0	3488.0	184	835.4	880.4	3341.6	3521.6	226	843.8	888.8	3375.2	3555.2
143	827.2	872.2	3308.8	3488.8	185	835.6	880.6	3342.4	3522.4	227	844.0	889.0	3376.0	3556.0
144	827.4	872.4	3309.6	3489.6	186	835.8	880.8	3343.2	3523.2	228	844.2	889.2	3376.8	3556.8
145	827.6	872.6	3310.4	3490.4	187	836.0	881.0	3344.0	3524.0	229	844.4	889.4	3377.6	3557.6
146	827.8	872.8	3311.2	3491.2	188	836.2	881.2	3344.8	3524.8	230	844.6	889.6	3378.4	3558.4
147	828.0	873.0	3312.0	3492.0	189	836.4	881.4	3345.6	3525.6	231	844.8	889.8	3379.2	3559.2
148	828.2	873.2	3312.8	3492.8	190	836.6	881.6	3346.4	3526.4	232	845.0	890.0	3380.0	3560.0
149	828.4	873.4	3313.6	3493.6	191	836.8	881.8	3347.2	3527.2	233	845.2	890.2	3380.8	3560.8
150	828.6	873.6	3314.4	3494.4	192	837.0	882.0	3348.0	3528.0	234	845.4	890.4	3381.6	3561.6
151	828.8	873.8	3315.2	3495.2	193	837.2	882.2	3348.8	3528.8	235	845.6	890.6	3382.4	3562.4
152	829.0	874.0	3316.0	3496.0	194	837.4	882.4	3349.6	3529.6	236	845.8	890.8	3383.2	3563.2
153	829.2	874.2	3316.8	3496.8	195	837.6	882.6	3350.4	3530.4	237	846.0	891.0	3384.0	3564.0
154	829.4	874.4	3317.6	3497.6	196	837.8	882.8	3351.2	3531.2	238	846.2	891.2	3384.8	3564.8
155	829.6	874.6	3318.4	3498.4	197	838.0	883.0	3352.0	3532.0	239	846.4	891.4	3385.6	3565.6
156	829.8	874.8	3319.2	3499.2	198	838.2	883.2	3352.8	3532.8	240	846.6	891.6	3386.4	3566.4
157	830.0	875.0	3320.0	3500.0	199	838.4	883.4	3353.6	3533.6	241	846.8	891.8	3387.2	3567.2
158	830.2	875.2	3320.8	3500.8	200	838.6	883.6	3354.4	3534.4	242	847.0	892.0	3388.0	3568.0
159	830.4	875.4	3321.6	3501.6	201	838.8	883.8	3355.2	3535.2	243	847.2	892.2	3388.8	3568.8
160	830.6	875.6	3322.4	3502.4	202	839.0	884.0	3356.0	3536.0	244	847.4	892.4	3389.6	3569.6
161	830.8	875.8	3323.2	3503.2	203	839.2	884.2	3356.8	3536.8	245	847.6	892.6	3390.4	3570.4
162	831.0	876.0	3324.0	3504.0	204	839.4	884.4	3357.6	3537.6	246	847.8	892.8	3391.2	3571.2
163	831.2	876.2	3324.8	3504.8	205	839.6	884.6	3358.4	3538.4	247	848.0	893.0	3392.0	3572.0
164	831.4	876.4	3325.6	3505.6	206	839.8	884.8	3359.2	3539.2	248	848.2	893.2	3392.8	3572.8
165	831.6	876.6	3326.4	3506.4	207	840.0	885.0	3360.0	3540.0	249	848.4	893.4	3393.6	3573.6
166	831.8	876.8	3327.2	3507.2	208	840.2	885.2	3360.8	3540.8	250	848.6	893.6	3394.4	3574.4
167	832.0	877.0	3328.0	3508.0	209	840.4	885.4	3361.6	3541.6	251	848.8	893.8	3395.2	3575.2

EGSM900 frequencies

CH	TX	RX	VCO TX	VCO RX	CH	TX	RX	VCO TX	VCO RX	CH	TX	RX	VCO TX	VCO RX
975	880,2	925,2	3520,8	3700,8	1	890,2	935,2	3560,8	3740,8	63	902,6	947,6	3610,4	3790,4
976	880,4	925,4	3521,6	3701,6	2	890,4	935,4	3561,6	3741,6	64	902,8	947,8	3611,2	3791,2
977	880,6	925,6	3522,4	3702,4	3	890,6	935,6	3562,4	3742,4	65	903,0	948,0	3612,0	3792,0
978	880,8	925,8	3523,2	3703,2	4	890,8	935,8	3563,2	3743,2	66	903,2	948,2	3612,8	3792,8
979	881,0	926,0	3524,0	3704,0	5	891,0	936,0	3564,0	3744,0	67	903,4	948,4	3613,6	3793,6
980	881,2	926,2	3524,8	3704,8	6	891,2	936,2	3564,8	3744,8	68	903,6	948,6	3614,4	3794,4
981	881,4	926,4	3525,6	3705,6	7	891,4	936,4	3565,6	3745,6	69	903,8	948,8	3615,2	3795,2
982	881,6	926,6	3526,4	3706,4	8	891,6	936,6	3566,4	3746,4	70	904,0	949,0	3616,0	3796,0
983	881,8	926,8	3527,2	3707,2	9	891,8	936,8	3567,2	3747,2	71	904,2	949,2	3616,8	3796,8
984	882,0	927,0	3528,0	3708,0	10	892,0	937,0	3568,0	3748,0	72	904,4	949,4	3617,6	3797,6
985	882,2	927,2	3528,8	3708,8	11	892,2	937,2	3568,8	3748,8	73	904,6	949,6	3618,4	3798,4
986	882,4	927,4	3529,6	3709,6	12	892,4	937,4	3569,6	3749,6	74	904,8	949,8	3619,2	3799,2
987	882,6	927,6	3530,4	3710,4	13	892,6	937,6	3570,4	3750,4	75	905,0	950,0	3620,0	3800,0
988	882,8	927,8	3531,2	3711,2	14	892,8	937,8	3571,2	3751,2	76	905,2	950,2	3620,8	3800,8
989	883,0	928,0	3532,0	3712,0	15	893,0	938,0	3572,0	3752,0	77	905,4	950,4	3621,6	3801,6
990	883,2	928,2	3532,8	3712,8	16	893,2	938,2	3572,8	3752,8	78	905,6	950,6	3622,4	3802,4
991	883,4	928,4	3533,6	3713,6	17	893,4	938,4	3573,6	3753,6	79	905,8	950,8	3623,2	3803,2
992	883,6	928,6	3534,4	3714,4	18	893,6	938,6	3574,4	3754,4	80	906,0	951,0	3624,0	3804,0
993	883,8	928,8	3535,2	3715,2	19	893,8	938,8	3575,2	3755,2	81	906,2	951,2	3624,8	3804,8
994	884,0	929,0	3536,0	3716,0	20	894,0	939,0	3576,0	3756,0	82	906,4	951,4	3625,6	3805,6
995	884,2	929,2	3536,8	3716,8	21	894,2	939,2	3576,8	3756,8	83	906,6	951,6	3626,4	3806,4
996	884,4	929,4	3537,6	3717,6	22	894,4	939,4	3577,6	3757,6	84	906,8	951,8	3627,2	3807,2
997	884,6	929,6	3538,4	3718,4	23	894,6	939,6	3578,4	3758,4	85	907,0	952,0	3628,0	3808,0
998	884,8	929,8	3539,2	3719,2	24	894,8	939,8	3579,2	3759,2	86	907,2	952,2	3628,8	3808,8
999	885,0	930,0	3540,0	3720,0	25	895,0	940,0	3580,0	3760,0	87	907,4	952,4	3629,6	3809,6
1000	885,2	930,2	3540,8	3720,8	26	895,2	940,2	3580,8	3760,8	88	907,6	952,6	3630,4	3810,4
1001	885,4	930,4	3541,6	3721,6	27	895,4	940,4	3581,6	3761,6	89	907,8	952,8	3631,2	3811,2
1002	885,6	930,6	3542,4	3722,4	28	895,6	940,6	3582,4	3762,4	90	908,0	953,0	3632,0	3812,0
1003	885,8	930,8	3543,2	3723,2	29	895,8	940,8	3583,2	3763,2	91	908,2	953,2	3632,8	3812,8
1004	886,0	931,0	3544,0	3724,0	30	896,0	941,0	3584,0	3764,0	92	908,4	953,4	3633,6	3813,6
1005	886,2	931,2	3544,8	3724,8	31	896,2	941,2	3584,8	3764,8	93	908,6	953,6	3634,4	3814,4
1006	886,4	931,4	3545,6	3725,6	32	896,4	941,4	3585,6	3765,6	94	908,8	953,8	3635,2	3815,2
1007	886,6	931,6	3546,4	3726,4	33	896,6	941,6	3586,4	3766,4	95	909,0	954,0	3636,0	3816,0
1008	886,8	931,8	3547,2	3727,2	34	896,8	941,8	3587,2	3767,2	96	909,2	954,2	3636,8	3816,8
1009	887,0	932,0	3548,0	3728,0	35	897,0	942,0	3588,0	3768,0	97	909,4	954,4	3637,6	3817,6
1010	887,2	932,2	3548,8	3728,8	36	897,2	942,2	3588,8	3768,8	98	909,6	954,6	3638,4	3818,4
1011	887,4	932,4	3549,6	3729,6	37	897,4	942,4	3589,6	3769,6	99	909,8	954,8	3639,2	3819,2
1012	887,6	932,6	3550,4	3730,4	38	897,6	942,6	3590,4	3770,4	100	910,0	955,0	3640,0	3820,0
1013	887,8	932,8	3551,2	3731,2	39	897,8	942,8	3591,2	3771,2	101	910,2	955,2	3640,8	3820,8
1014	888,0	933,0	3552,0	3732,0	40	898,0	943,0	3592,0	3772,0	102	910,4	955,4	3641,6	3821,6
1015	888,2	933,2	3552,8	3732,8	41	898,2	943,2	3592,8	3772,8	103	910,6	955,6	3642,4	3822,4
1016	888,4	933,4	3553,6	3733,6	42	898,4	943,4	3593,6	3773,6	104	910,8	955,8	3643,2	3823,2
1017	888,6	933,6	3554,4	3734,4	43	898,6	943,6	3594,4	3774,4	105	911,0	956,0	3644,0	3824,0
1018	888,8	933,8	3555,2	3735,2	44	898,8	943,8	3595,2	3775,2	106	911,2	956,2	3644,8	3824,8
1019	889,0	934,0	3556,0	3736,0	45	899,0	944,0	3596,0	3776,0	107	911,4	956,4	3645,6	3825,6
1020	889,2	934,2	3556,8	3736,8	46	899,2	944,2	3596,8	3776,8	108	911,6	956,6	3646,4	3826,4
1021	889,4	934,4	3557,6	3737,6	47	899,4	944,4	3597,6	3777,6	109	911,8	956,8	3647,2	3827,2
1022	889,6	934,6	3558,4	3738,4	48	899,6	944,6	3598,4	3778,4	110	912,0	957,0	3648,0	3828,0
1023	889,8	934,8	3559,2	3739,2	49	899,8	944,8	3599,2	3779,2	111	912,2	957,2	3648,8	3828,8
0	890,0	935,0	3560,0	3740,0	50	900,0	945,0	3600,0	3780,0	112	912,4	957,4	3649,6	3829,6
					51	900,2	945,2	3600,8	3780,8	113	912,6	957,6	3650,4	3830,4
					52	900,4	945,4	3601,6	3781,6	114	912,8	957,8	3651,2	3831,2
					53	900,6	945,6	3602,4	3782,4	115	913,0	958,0	3652,0	3832,0
					54	900,8	945,8	3603,2	3783,2	116	913,2	958,2	3652,8	3832,8
					55	901,0	946,0	3604,0	3784,0	117	913,4	958,4	3653,6	3833,6
					56	901,2	946,2	3604,8	3784,8	118	913,6	958,6	3654,4	3834,4
					57	901,4	946,4	3605,6	3785,6	119	913,8	958,8	3655,2	3835,2
					58	901,6	946,6	3606,4	3786,4	120	914,0	959,0	3656,0	3836,0
					59	901,8	946,8	3607,2	3787,2	121	914,2	959,2	3656,8	3836,8
					60	902,0	947,0	3608,0	3788,0	122	914,4	959,4	3657,6	3837,6
					61	902,2	947,2	3608,8	3788,8	123	914,6	959,6	3658,4	3838,4
					62	902,4	947,4	3609,6	3789,6	124	914,8	959,8	3659,2	3839,2

GSM1800 frequencies

Ch	Tx	Rx	VCO Tx	VCO Rx	Ch	Tx	Rx	VCO Tx	VCO Rx	Ch	Tx	Rx	VCO Tx	VCO Rx	Ch	Tx	Rx	VCO Tx	VCO Rx
512	1710.2	1805.2	3420.4	3610.4	606	1729.0	1824.0	3458.0	3648.0	700	1747.8	1842.8	3495.6	3685.6	793	1766.4	1861.4	3532.8	3722.8
513	1710.4	1805.4	3420.8	3610.8	607	1729.2	1824.2	3458.4	3648.4	701	1748.0	1843.0	3496.0	3686.0	794	1766.6	1861.6	3533.2	3723.2
514	1710.6	1805.6	3421.2	3611.2	608	1729.4	1824.4	3458.8	3648.8	702	1748.2	1843.2	3496.4	3686.4	795	1766.8	1861.8	3533.6	3723.6
515	1710.8	1805.8	3421.6	3611.6	609	1729.6	1824.6	3459.2	3649.2	703	1748.4	1843.4	3496.8	3686.8	796	1767.0	1862.0	3534.0	3724.0
516	1711.0	1806.0	3422.0	3612.0	610	1729.8	1824.8	3459.6	3649.6	704	1748.6	1843.6	3497.2	3687.2	797	1767.2	1862.2	3534.4	3724.4
517	1711.2	1806.2	3422.4	3612.4	611	1730.0	1825.0	3460.0	3650.0	705	1748.8	1843.8	3497.6	3687.6	798	1767.4	1862.4	3534.8	3724.8
518	1711.4	1806.4	3422.8	3612.8	612	1730.2	1825.2	3460.4	3650.4	706	1749.0	1844.0	3498.0	3688.0	799	1767.6	1862.6	3535.2	3725.2
519	1711.6	1806.6	3423.2	3613.2	613	1730.4	1825.4	3460.8	3650.8	707	1749.2	1844.2	3498.4	3688.4	800	1767.8	1862.8	3535.6	3725.6
520	1711.8	1806.8	3423.6	3613.6	614	1730.6	1825.6	3461.2	3651.2	708	1749.4	1844.4	3498.8	3688.8	801	1768.0	1863.0	3536.0	3726.0
521	1712.0	1807.0	3424.0	3614.0	615	1730.8	1825.8	3461.6	3651.6	709	1749.6	1844.6	3499.2	3689.2	802	1768.2	1863.2	3536.4	3726.4
522	1712.2	1807.2	3424.4	3614.4	616	1731.0	1826.0	3462.0	3652.0	710	1749.8	1844.8	3499.6	3689.6	803	1768.4	1863.4	3536.8	3726.8
523	1712.4	1807.4	3424.8	3614.8	617	1731.2	1826.2	3462.4	3652.4	711	1750.0	1845.0	3500.0	3690.0	804	1768.6	1863.6	3537.2	3727.2
524	1712.6	1807.6	3425.2	3615.2	618	1731.4	1826.4	3462.8	3652.8	712	1750.2	1845.2	3500.4	3690.4	805	1768.8	1863.8	3537.6	3727.6
525	1712.8	1807.8	3425.6	3615.6	619	1731.6	1826.6	3463.2	3653.2	713	1750.4	1845.4	3500.8	3690.8	806	1769.0	1864.0	3538.0	3728.0
526	1713.0	1808.0	3426.0	3616.0	620	1731.8	1826.8	3463.6	3653.6	714	1750.6	1845.6	3501.2	3691.2	807	1769.2	1864.2	3538.4	3728.4
527	1713.2	1808.2	3426.4	3616.4	621	1732.0	1827.0	3464.0	3654.0	715	1750.8	1845.8	3501.6	3691.6	808	1769.4	1864.4	3538.8	3728.8
528	1713.4	1808.4	3426.8	3616.8	622	1732.2	1827.2	3464.4	3654.4	716	1751.0	1846.0	3502.0	3692.0	809	1769.6	1864.6	3539.2	3729.2
529	1713.6	1808.6	3427.2	3617.2	623	1732.4	1827.4	3464.8	3654.8	717	1751.2	1846.2	3502.4	3692.4	810	1769.8	1864.8	3539.6	3729.6
530	1713.8	1808.8	3427.6	3617.6	624	1732.6	1827.6	3465.2	3655.2	718	1751.4	1846.4	3502.8	3692.8	811	1770.0	1865.0	3540.0	3730.0
531	1714.0	1809.0	3428.0	3618.0	625	1732.8	1827.8	3465.6	3655.6	719	1751.6	1846.6	3503.2	3693.2	812	1770.2	1865.2	3540.4	3730.4
532	1714.2	1809.2	3428.4	3618.4	626	1733.0	1828.0	3466.0	3656.0	720	1751.8	1846.8	3503.6	3693.6	813	1770.4	1865.4	3540.8	3730.8
533	1714.4	1809.4	3428.8	3618.8	627	1733.2	1828.2	3466.4	3656.4	721	1752.0	1847.0	3504.0	3694.0	814	1770.6	1865.6	3541.2	3731.2
534	1714.6	1809.6	3429.2	3619.2	628	1733.4	1828.4	3466.8	3656.8	722	1752.2	1847.2	3504.4	3694.4	815	1770.8	1865.8	3541.6	3731.6
535	1714.8	1809.8	3429.6	3619.6	629	1733.6	1828.6	3467.2	3657.2	723	1752.4	1847.4	3504.8	3694.8	816	1771.0	1866.0	3542.0	3732.0
536	1715.0	1810.0	3430.0	3620.0	630	1733.8	1828.8	3467.6	3657.6	724	1752.6	1847.6	3505.2	3695.2	817	1771.2	1866.2	3542.4	3732.4
537	1715.2	1810.2	3430.4	3620.4	631	1734.0	1829.0	3468.0	3658.0	725	1752.8	1847.8	3505.6	3695.6	818	1771.4	1866.4	3542.8	3732.8
538	1715.4	1810.4	3430.8	3620.8	632	1734.2	1829.2	3468.4	3658.4	726	1753.0	1848.0	3506.0	3696.0	819	1771.6	1866.6	3543.2	3733.2
539	1715.6	1810.6	3431.2	3621.2	633	1734.4	1829.4	3468.8	3658.8	727	1753.2	1848.2	3506.4	3696.4	820	1771.8	1866.8	3543.6	3733.6
540	1715.8	1810.8	3431.6	3621.6	634	1734.6	1829.6	3469.2	3659.2	728	1753.4	1848.4	3506.8	3696.8	821	1772.0	1867.0	3544.0	3734.0
541	1716.0	1811.0	3432.0	3622.0	635	1734.8	1829.8	3469.6	3659.6	729	1753.6	1848.6	3507.2	3697.2	822	1772.2	1867.2	3544.4	3734.4
542	1716.2	1811.2	3432.4	3622.4	636	1735.0	1830.0	3470.0	3660.0	730	1753.8	1848.8	3507.6	3697.6	823	1772.4	1867.4	3544.8	3734.8
543	1716.4	1811.4	3432.8	3622.8	637	1735.2	1830.2	3470.4	3660.4	731	1754.0	1849.0	3508.0	3698.0	824	1772.6	1867.6	3545.2	3735.2
544	1716.6	1811.6	3433.2	3623.2	638	1735.4	1830.4	3470.8	3660.8	732	1754.2	1849.2	3508.4	3698.4	825	1772.8	1867.8	3545.6	3735.6
545	1716.8	1811.8	3433.6	3623.6	639	1735.6	1830.6	3471.2	3661.2	733	1754.4	1849.4	3508.8	3698.8	826	1773.0	1868.0	3546.0	3736.0
546	1717.0	1812.0	3434.0	3624.0	640	1735.8	1830.8	3471.6	3661.6	734	1754.6	1849.6	3509.2	3699.2	827	1773.2	1868.2	3546.4	3736.4
547	1717.2	1812.2	3434.4	3624.4	641	1736.0	1831.0	3472.0	3662.0	735	1754.8	1849.8	3509.6	3699.6	828	1773.4	1868.4	3546.8	3736.8
548	1717.4	1812.4	3434.8	3624.8	642	1736.2	1831.2	3472.4	3662.4	736	1755.0	1850.0	3510.0	3700.0	829	1773.6	1868.6	3547.2	3737.2
549	1717.6	1812.6	3435.2	3625.2	643	1736.4	1831.4	3472.8	3662.8	737	1755.2	1850.2	3510.4	3700.4	830	1773.8	1868.8	3547.6	3737.6
550	1717.8	1812.8	3435.6	3625.6	644	1736.6	1831.6	3473.2	3663.2	738	1755.4	1850.4	3510.8	3700.8	831	1774.0	1869.0	3548.0	3738.0
551	1718.0	1813.0	3436.0	3626.0	645	1736.8	1831.8	3473.6	3663.6	739	1755.6	1850.6	3511.2	3701.2	832	1774.2	1869.2	3548.4	3738.4
552	1718.2	1813.2	3436.4	3626.4	646	1737.0	1832.0	3474.0	3664.0	740	1755.8	1850.8	3511.6	3701.6	833	1774.4	1869.4	3548.8	3738.8
553	1718.4	1813.4	3436.8	3626.8	647	1737.2	1832.2	3474.4	3664.4	741	1756.0	1851.0	3512.0	3702.0	834	1774.6	1869.6	3549.2	3739.2
554	1718.6	1813.6	3437.2	3627.2	648	1737.4	1832.4	3474.8	3664.8	742	1756.2	1851.2	3512.4	3702.4	835	1774.8	1869.8	3549.6	3739.6
555	1718.8	1813.8	3437.6	3627.6	649	1737.6	1832.6	3475.2	3665.2	743	1756.4	1851.4	3512.8	3702.8	836	1775.0	1870.0	3550.0	3740.0
556	1719.0	1814.0	3438.0	3628.0	650	1737.8	1832.8	3475.6	3665.6	744	1756.6	1851.6	3513.2	3703.2	837	1775.2	1870.2	3550.4	3740.4
557	1719.2	1814.2	3438.4	3628.4	651	1738.0	1833.0	3476.0	3666.0	745	1756.8	1851.8	3513.6	3703.6	838	1775.4	1870.4	3550.8	3740.8
558	1719.4	1814.4	3438.8	3628.8	652	1738.2	1833.2	3476.4	3666.4	746	1757.0	1852.0	3514.0	3704.0	839	1775.6	1870.6	3551.2	3741.2
559	1719.6	1814.6	3439.2	3629.2	653	1738.4	1833.4	3476.8	3666.8	747	1757.2	1852.2	3514.4	3704.4	840	1775.8	1870.8	3551.6	3741.6
560	1719.8	1814.8	3439.6	3629.6	654	1738.6	1833.6	3477.2	3667.2	748	1757.4	1852.4	3514.8	3704.8	841	1776.0	1871.0	3552.0	3742.0
561	1720.0	1815.0	3440.0	3630.0	655	1738.8	1833.8	3477.6	3667.6	749	1757.6	1852.6	3515.2	3705.2	842	1776.2	1871.2	3552.4	3742.4
562	1720.2	1815.2	3440.4	3630.4	656	1739.0	1834.0	3478.0	3668.0	750	1757.8	1852.8	3515.6	3705.6	843	1776.4	1871.4	3552.8	3742.8
563	1720.4	1815.4	3440.8	3630.8	657	1739.2	1834.2	3478.4	3668.4	751	1758.0	1853.0	3516.0	3706.0	844	1776.6	1871.6	3553.2	3743.2
564	1720.6	1815.6	3441.2	3631.2	658	1739.4	1834.4	3478.8	3668.8	752	1758.2	1853.2	3516.4	3706.4	845	1776.8	1871.8	3553.6	3743.6
565	1720.8	1815.8	3441.6	3631.6	659	1739.6	1834.6	3479.2	3669.2	753	1758.4	1853.4	3516.8	3706.8	846	1777.0	1872.0	3554.0	3744.0
566	1721.0	1816.0	3442.0	3632.0	660	1739.8	1834.8	3479.6	3669.6	754	1758.6	1853.6	3517.2	3707.2	847	1777.2	1872.2	3554.4	3744.4
567	1721.2	1816.2	3442.4	3632.4	661	1740.0	1835.0	3480.0	3670.0	755	1758.8	1853.8	3517.6	3707.6	848	1777.4	1872.4	3554.8	3744.8
568	1721.4	1816.4	3442.8	3632.8	662	1740.2	1835.2	3480.4	3670.4	756	1759.0	1854.0	3518.0	3708.0	849	1777.6	1872.6	3555.2	3745.2
569	1721.6	1816.6	3443.2	3633.2	663	1740.4	1835.4	3480.8	3670.8	757	1759.2	1854.2	3518.4	3708.4	850	1777.8	1872.8	3555.6	3745.6
570	1721.8	1816.8	3443.6	3633.6	664	1740.6	1835.6	3481.2	3671.2	758	1759.4	1854.4	3518.8	3708.8	851	1778.0	1873.0	3556.0	3746.0
571	1722.0	1817.0	3444.0	3634.0	665	1740.8	1835.8	3481.6	3671.6	759	1759.6	1854.6	3519.2	3709.2	852	1778.2	1873.2	3556.4	3746.4
572	1722.2	1817.2	3444.4	3634.4	666	1741.0	1836.0	3482.0	3672.0	760	1759.8	1854.8	3519.6	3709.6	853	1778.4	1873.4	3556.8	3746.8
573	1722.4	1817.4	3444.8	3634.8	667	1741.2	1836.2	3482.4	3672.4	761	1760.0	1855.0	3520.0	3710.0	854	1778.6	1873.6	3557.2	3747.2
574	1722.6	1817.6	3445.2	3635.2	668	1741.4	1836.4	3482.8	3672.8	762	1760.2	1855.2	3520.4	3710.4	855	1778.8	1873.8	3557.6	3747.6
575	1722.8	1817.8	3445.6	3635.6	669	1741.6	1836.6	3483.2	3673.2	763	1760.4	1855.4	3520.8	3710.8	856	1779.0	1874.0	3558.0	3748.0
576	1723.0	1818.0	3446.0	3636.0	670	1741.8	1836.8	3483.6	3673.6	764	1760.6	1855.6	3521.2	3711.2	857	1779.2	1874.2	3558.4	3748.4
577	1723.2	1818.2	3446.4	3636.4	671	1742.0	1837.0	3484.0	3674.0	765	1760.8	1855.8	3521.6	3711.6	858	1779.4	1874.4	3558.8	3748.8
578	1723.4	1818.4	3446.8	3636.8	672	1742.2	1837.2	3484.4	3674.4	766	1761.0	1856.0	3522.0	3712.0	859	1779.6	1874.6	3559.2	3749.2
579	1723.6	1818.6	3447.2	3637.2	673	1742.4	1837.4	3484.8	3674.8	767	1761.2	1856.2	3522.4	3712.4	860	1779.8	1874.8	3559.6	3749.6
580	1723.8	1818.8	3447.6	3637.6	674	1742.6	1837.6	3485.2	3675.2	768	1761.4	1856.4	3522.8	3712.8	861	1780.0	1875.0	3560.0	3750.0
581	1724.0	1819.0	3448.0	3638.0	675	1742.8	1837.8	3485.6	3675.6	769	1761.6	1856.6	3523.2	3713.2	862	1780.2	1875.2	3560.4	3750.4
582	1724.2	1819.2	3448.4	3638.4	676	1743.0	1838.0	3486.0	3676.0	770	1761.8	1856.8	3523.6	3713.6	863	1780.4	1875.4	3560.8	3750.8
583	1724.4	1819.4	3448.8	3638.8	677	1743.2	1838.2	3486.4	3676.4	771	1762.0	1857.0	3524.0	3714.0	864	1780.6	1875.6	3561.2	3751.2
584	1724.6	1819.6	3449.2	3639.2	678	1743.4	1838.4	3486.8	3676.8	772	1762.2	1857.2	3524.4	3714.4	865	1780.8	1875.8	3561.6	3751.6
585	1724.8	1819.8	3449.6	3639.6	679	1743.6	1838.6	3487.2	3677.2	773	1762.4	1857.4	3524.8	3714.8	866	1781.0	1876.0	3562.0	3752.0
586	1725.0	1820.0	3450.0	3640.0	680	1743.8	1838.8	3487.6	3677.6	774	1762.6	1857.6	3525.2	3715.2	867	1781.2	1876.2	3562.4	3752.4
587	1725.2	1820.2	3450.4	3640.4	681	1744.0	1839.0	3488.0	3678.0	775	1762.8	1857.8	3525.6	3715.6	868	1781.4	1876.4	3562.8	3752.8
588	1725.4	1820.4	3450.8	3640.8	682	1744.2	1839.2	3488.4	3678.4	776	1763.0	1858.0	3526.0	3716.0	869	1781.6	1876.6	3563.2	3753.2
589	1725.6	1820.6	3451.2	3641.2	683	1744.4	1839.4	3488.8	3678.8	777	1763.2	1858.2	3526.4	3716.4	870	1781.8	1876.8	3563.6	3753.6
590	1725.8	1820.8	3451.6	3641.6	684	1744.6	1839.6	3489.2	3679.2	778	1763.4	1858.4	3526.8	3716.8	871	1782.0	1877.0	3564.0	3754.0
591	1726.0	1821.0	3452.0	3642.0	685	1744.8	1839.8	3489.6	3679.6	779	1763.6	1858.6	3527.2	3717.2	872	1782.2	1877.2	3564.4	3754.4
592	1726.2	1821.2	3452.4	3642.4	686	1745.0	1840.0	3490.0	3680.0	780	1763.8	1858.8	3527.6	3717.6	873	1782.4	1877.4	3564.8	3754.8
593	1726.4	1821.4	3452.8	3642.8	687	1745.2	1840.2	3490.4	3680.4	781	1764.0	1859.0	3528.0	3718.0	874	1782.6	1877.6	3565.2	3755.2
594	1726.6	1821.6	3453.2	3643.2	688	1745.4	1840.4	3490.8	3680.8	782	1764.2	1859.2	3528.4	3718.4	875	1782.8	1877.8	3565.6	3755.6
595	1726.8	1821.8	3453.6	3643.6	689	1745.6	1840.6	3491.2	3681.2	783	1764.4	1859.4	3528.8	3718.8	876	1783.0	1878.0	3566.0	3756.0
596	1727.0	1822.0	3454.0	3644.0	690	1745.8	1840.8	3491.6	3681.6	784	1764.6	1859.6	3529.2	3719.2	877	1783.2	1878.2	3566.4	3756.4
597	1727.2	1822.2	3454.4	3644.4	691	1746.0	1841.0	3492.0	3682.0	785	1764.8	1859.8	3529.6	3719.6	878	1783.4	1878.4	3566.8	3756.8
598	1727.4	1822.4	3454.8	3644.8	692	1746.2	1841.2	3492.4	3682.4	786	1765.0	1860.0	3530.0	3720.0	879	1783.6	1878.6	3567.2	3757.2
599	1727.6	1822.6	3455.2	3645.2	693	1746.4	1841.4	3492.8	3682.8	787	1765.2	1860.2	3530.4	3720.4	880	1783.8	1878.8	3567.6	3757.6
600	1727.8	1822.8	3455.6	3645.6	694	1746.6	1841.6	3493.2	3683.2	788	1765.4	1860.4	3530.8	3720.8	881	1784.0	1879.0	3568.0	3758.0
601	1728.0	1823.0	3456.0	3646.0	695	1746.8	1841.8	3493.6	3683.6	789	1765.6	1860.6	3531.2	3721.2	882	1784.2	1879.2	3568.4	3758.4
602	1728.2	1823.2	3456.4	3646.4	696	1747.0	1842.0	3494.0	3684.0	790	1765.8	1860.8	3531.6	3721.6	883	1784.4	1879.4	3568.8	3758.8
603	1728.4	1823.4	3456.8	3646.8	697	1747.2	1842.2	3494.4	3684.4	791	1766.0	1861.0	3532.0	3722.0	884	1784.6	1879.6	3569.2	3759.2
604	1728.6	1823.6	3457.2	3647.2	698	1747.4	1842.4	3494.8	3684.8	792	1766.2	1861.2	3532.4	3722.4	885	1784.8	1879.8	3569.6	3759.6
605	1728.8	1823.8	3457.6	3647.6	699	1747.6	1842.6	3495.2	3685.2										

GSM1900 frequencies

CH	TX	RX	VCO TX	VCO RX	CH	TX	RX	VCO TX	VCO RX	CH	TX	RX	VCO TX	VCO RX	CH	TX	RX	VCO TX	VCO RX
512	1850,2	1930,2	3700,4	3860,4	606	1869,0	1949,0	3738,0	3898,0	700	1887,8	1967,8	3775,6	3935,6	794	1906,6	1986,6	3813,2	3973,2
513	1850,4	1930,4	3700,8	3860,8	607	1869,2	1949,2	3738,4	3898,4	701	1888,0	1968,0	3776,0	3936,0	795	1906,8	1986,8	3813,6	3973,6
514	1850,6	1930,6	3701,2	3861,2	608	1869,4	1949,4	3738,8	3898,8	702	1888,2	1968,2	3776,4	3936,4	796	1907,0	1987,0	3814,0	3974,0
515	1850,8	1930,8	3701,6	3861,6	609	1869,6	1949,6	3739,2	3899,2	703	1888,4	1968,4	3776,8	3936,8	797	1907,2	1987,2	3814,4	3974,4
516	1851,0	1931,0	3702,0	3862,0	610	1869,8	1949,8	3739,6	3899,6	704	1888,6	1968,6	3777,2	3937,2	798	1907,4	1987,4	3814,8	3974,8
517	1851,2	1931,2	3702,4	3862,4	611	1870,0	1950,0	3740,0	3900,0	705	1888,8	1968,8	3777,6	3937,6	799	1907,6	1987,6	3815,2	3975,2
518	1851,4	1931,4	3702,8	3862,8	612	1870,2	1950,2	3740,4	3900,4	706	1889,0	1969,0	3778,0	3938,0	800	1907,8	1987,8	3815,6	3975,6
519	1851,6	1931,6	3703,2	3863,2	613	1870,4	1950,4	3740,8	3900,8	707	1889,2	1969,2	3778,4	3938,4	801	1908,0	1988,0	3816,0	3976,0
520	1851,8	1931,8	3703,6	3863,6	614	1870,6	1950,6	3741,2	3901,2	708	1889,4	1969,4	3778,8	3938,8	802	1908,2	1988,2	3816,4	3976,4
521	1852,0	1932,0	3704,0	3864,0	615	1870,8	1950,8	3741,6	3901,6	709	1889,6	1969,6	3779,2	3939,2	803	1908,4	1988,4	3816,8	3976,8
522	1852,2	1932,2	3704,4	3864,4	616	1871,0	1951,0	3742,0	3902,0	710	1889,8	1969,8	3779,6	3939,6	804	1908,6	1988,6	3817,2	3977,2
523	1852,4	1932,4	3704,8	3864,8	617	1871,2	1951,2	3742,4	3902,4	711	1890,0	1970,0	3780,0	3940,0	805	1908,8	1988,8	3817,6	3977,6
524	1852,6	1932,6	3705,2	3865,2	618	1871,4	1951,4	3742,8	3902,8	712	1890,2	1970,2	3780,4	3940,4	806	1909,0	1989,0	3818,0	3978,0
525	1852,8	1932,8	3705,6	3865,6	619	1871,6	1951,6	3743,2	3903,2	713	1890,4	1970,4	3780,8	3940,8	807	1909,2	1989,2	3818,4	3978,4
526	1853,0	1933,0	3706,0	3866,0	620	1871,8	1951,8	3743,6	3903,6	714	1890,6	1970,6	3781,2	3941,2	808	1909,4	1989,4	3818,8	3978,8
527	1853,2	1933,2	3706,4	3866,4	621	1872,0	1952,0	3744,0	3904,0	715	1890,8	1970,8	3781,6	3941,6	809	1909,6	1989,6	3819,2	3979,2
528	1853,4	1933,4	3706,8	3866,8	622	1872,2	1952,2	3744,4	3904,4	716	1891,0	1971,0	3782,0	3942,0	810	1909,8	1989,8	3819,6	3979,6
529	1853,6	1933,6	3707,2	3867,2	623	1872,4	1952,4	3744,8	3904,8	717	1891,2	1971,2	3782,4	3942,4					
530	1853,8	1933,8	3707,6	3867,6	624	1872,6	1952,6	3745,2	3905,2	718	1891,4	1971,4	3782,8	3942,8					
531	1854,0	1934,0	3708,0	3868,0	625	1872,8	1952,8	3745,6	3905,6	719	1891,6	1971,6	3783,2	3943,2					
532	1854,2	1934,2	3708,4	3868,4	626	1873,0	1953,0	3746,0	3906,0	720	1891,8	1971,8	3783,6	3943,6					
533	1854,4	1934,4	3708,8	3868,8	627	1873,2	1953,2	3746,4	3906,4	721	1892,0	1972,0	3784,0	3944,0					
534	1854,6	1934,6	3709,2	3869,2	628	1873,4	1953,4	3746,8	3906,8	722	1892,2	1972,2	3784,4	3944,4					
535	1854,8	1934,8	3709,6	3869,6	629	1873,6	1953,6	3747,2	3907,2	723	1892,4	1972,4	3784,8	3944,8					
536	1855,0	1935,0	3710,0	3870,0	630	1873,8	1953,8	3747,6	3907,6	724	1892,6	1972,6	3785,2	3945,2					
537	1855,2	1935,2	3710,4	3870,4	631	1874,0	1954,0	3748,0	3908,0	725	1892,8	1972,8	3785,6	3945,6					
538	1855,4	1935,4	3710,8	3870,8	632	1874,2	1954,2	3748,4	3908,4	726	1893,0	1973,0	3786,0	3946,0					
539	1855,6	1935,6	3711,2	3871,2	633	1874,4	1954,4	3748,8	3908,8	727	1893,2	1973,2	3786,4	3946,4					
540	1855,8	1935,8	3711,6	3871,6	634	1874,6	1954,6	3749,2	3909,2	728	1893,4	1973,4	3786,8	3946,8					
541	1856,0	1936,0	3712,0	3872,0	635	1874,8	1954,8	3749,6	3909,6	729	1893,6	1973,6	3787,2	3947,2					
542	1856,2	1936,2	3712,4	3872,4	636	1875,0	1955,0	3750,0	3910,0	730	1893,8	1973,8	3787,6	3947,6					
543	1856,4	1936,4	3712,8	3872,8	637	1875,2	1955,2	3750,4	3910,4	731	1894,0	1974,0	3788,0	3948,0					
544	1856,6	1936,6	3713,2	3873,2	638	1875,4	1955,4	3750,8	3910,8	732	1894,2	1974,2	3788,4	3948,4					
545	1856,8	1936,8	3713,6	3873,6	639	1875,6	1955,6	3751,2	3911,2	733	1894,4	1974,4	3788,8	3948,8					
546	1857,0	1937,0	3714,0	3874,0	640	1875,8	1955,8	3751,6	3911,6	734	1894,6	1974,6	3789,2	3949,2					
547	1857,2	1937,2	3714,4	3874,4	641	1876,0	1956,0	3752,0	3912,0	735	1894,8	1974,8	3789,6	3949,6					
548	1857,4	1937,4	3714,8	3874,8	642	1876,2	1956,2	3752,4	3912,4	736	1895,0	1975,0	3790,0	3950,0					
549	1857,6	1937,6	3715,2	3875,2	643	1876,4	1956,4	3752,8	3912,8	737	1895,2	1975,2	3790,4	3950,4					
550	1857,8	1937,8	3715,6	3875,6	644	1876,6	1956,6	3753,2	3913,2	738	1895,4	1975,4	3790,8	3950,8					
551	1858,0	1938,0	3716,0	3876,0	645	1876,8	1956,8	3753,6	3913,6	739	1895,6	1975,6	3791,2	3951,2					
552	1858,2	1938,2	3716,4	3876,4	646	1877,0	1957,0	3754,0	3914,0	740	1895,8	1975,8	3791,6	3951,6					
553	1858,4	1938,4	3716,8	3876,8	647	1877,2	1957,2	3754,4	3914,4	741	1896,0	1976,0	3792,0	3952,0					
554	1858,6	1938,6	3717,2	3877,2	648	1877,4	1957,4	3754,8	3914,8	742	1896,2	1976,2	3792,4	3952,4					
555	1858,8	1938,8	3717,6	3877,6	649	1877,6	1957,6	3755,2	3915,2	743	1896,4	1976,4	3792,8	3952,8					
556	1859,0	1939,0	3718,0	3878,0	650	1877,8	1957,8	3755,6	3915,6	744	1896,6	1976,6	3793,2	3953,2					
557	1859,2	1939,2	3718,4	3878,4	651	1878,0	1958,0	3756,0	3916,0	745	1896,8	1976,8	3793,6	3953,6					
558	1859,4	1939,4	3718,8	3878,8	652	1878,2	1958,2	3756,4	3916,4	746	1897,0	1977,0	3794,0	3954,0					
559	1859,6	1939,6	3719,2	3879,2	653	1878,4	1958,4	3756,8	3916,8	747	1897,2	1977,2	3794,4	3954,4					
560	1859,8	1939,8	3719,6	3879,6	654	1878,6	1958,6	3757,2	3917,2	748	1897,4	1977,4	3794,8	3954,8					
561	1860,0	1940,0	3720,0	3880,0	655	1878,8	1958,8	3757,6	3917,6	749	1897,6	1977,6	3795,2	3955,2					
562	1860,2	1940,2	3720,4	3880,4	656	1879,0	1959,0	3758,0	3918,0	750	1897,8	1977,8	3795,6	3955,6					
563	1860,4	1940,4	3720,8	3880,8	657	1879,2	1959,2	3758,4	3918,4	751	1898,0	1978,0	3796,0	3956,0					
564	1860,6	1940,6	3721,2	3881,2	658	1879,4	1959,4	3758,8	3918,8	752	1898,2	1978,2	3796,4	3956,4					
565	1860,8	1940,8	3721,6	3881,6	659	1879,6	1959,6	3759,2	3919,2	753	1898,4	1978,4	3796,8	3956,8					
566	1861,0	1941,0	3722,0	3882,0	660	1879,8	1959,8	3759,6	3919,6	754	1898,6	1978,6	3797,2	3957,2					
567	1861,2	1941,2	3722,4	3882,4	661	1880,0	1960,0	3760,0	3920,0	755	1898,8	1978,8	3797,6	3957,6					
568	1861,4	1941,4	3722,8	3882,8	662	1880,2	1960,2	3760,4	3920,4	756	1899,0	1979,0	3798,0	3958,0					
569	1861,6	1941,6	3723,2	3883,2	663	1880,4	1960,4	3760,8	3920,8	757	1899,2	1979,2	3798,4	3958,4					
570	1861,8	1941,8	3723,6	3883,6	664	1880,6	1960,6	3761,2	3921,2	758	1899,4	1979,4	3798,8	3958,8					
571	1862,0	1942,0	3724,0	3884,0	665	1880,8	1960,8	3761,6	3921,6	759	1899,6	1979,6	3799,2	3959,2					
572	1862,2	1942,2	3724,4	3884,4	666	1881,0	1961,0	3762,0	3922,0	760	1899,8	1979,8	3799,6	3959,6					
573	1862,4	1942,4	3724,8	3884,8	667	1881,2	1961,2	3762,4	3922,4	761	1900,0	1980,0	3800,0	3960,0					
574	1862,6	1942,6	3725,2	3885,2	668	1881,4	1961,4	3762,8	3922,8	762	1900,2	1980,2	3800,4	3960,4					
575	1862,8	1942,8	3725,6	3885,6	669	1881,6	1961,6	3763,2	3923,2	763	1900,4	1980,4	3800,8	3960,8					
576	1863,0	1943,0	3726,0	3886,0	670	1881,8	1961,8	3763,6	3923,6	764	1900,6	1980,6	3801,2	3961,2					
577	1863,2	1943,2	3726,4	3886,4	671	1882,0	1962,0	3764,0	3924,0	765	1900,8	1980,8	3801,6	3961,6					
578	1863,4	1943,4	3726,8	3886,8	672	1882,2	1962,2	3764,4	3924,4	766	1901,0	1981,0	3802,0	3962,0					
579	1863,6	1943,6	3727,2	3887,2	673	1882,4	1962,4	3764,8	3924,8	767	1901,2	1981,2	3802,4	3962,4					
580	1863,8	1943,8	3727,6	3887,6	674	1882,6	1962,6	3765,2	3925,2	768	1901,4	1981,4	3802,8	3962,8					
581	1864,0	1944,0	3728,0	3888,0	675	1882,8	1962,8	3765,6	3925,6	769	1901,6	1981,6	3803,2	3963,2					
582	1864,2	1944,2	3728,4	3888,4	676	1883,0	1963,0	3766,0	3926,0	770	1901,8	1981,8	3803,6	3963,6					
583	1864,4	1944,4	3728,8	3888,8	677	1883,2	1963,2	3766,4	3926,4	771	1902,0	1982,0	3804,0	3964,0					
584	1864,6	1944,6	3729,2	3889,2	678	1883,4	1963,4	3766,8	3926,8	772	1902,2	1982,2	3804,4	3964,4					
585	1864,8	1944,8	3729,6	3889,6	679	1883,6	1963,6	3767,2	3927,2	773	1902,4	1982,4	3804,8	3964,8					
586	1865,0	1945,0	3730,0	3890,0	680	1883,8	1963,8	3767,6	3927,6	774	1902,6	1982,6	3805,2	3965,2					
587	1865,2	1945,2	3730,4	3890,4	681	1884,0	1964,0	3768,0	3928,0	775	1902,8	1982,8	3805,6	3965,6					
588	1865,4	1945,4	3730,8	3890,8	682	1884,2	1964,2	3768,4	3928,4	776	1903,0	1983,0	3806,0	3966,0					
589	1865,6	1945,6	3731,2	3891,2	683	1884,4	1964,4	3768,8	3928,8	777	1903,2	1983,2	3806,4	3966,4					
590	1865,8	1945,8	3731,6	3891,6	684	1884,6	1964,6	3769,2	3929,2	778	1903,4	1983,4	3806,8	3966,8					
591	1866,0	1946,0	3732,0	3892,0	685	1884,8	1964,8	3769,6	3929,6	779	1903,6	1983,6	3807,2	3967,2					
592	1866,2	1946,2	3732,4	3892,4	686	1885,0	1965,0	3770,0	3930,0	780	1903,8	1983,8	3807,6	3967,6					
593	1866,4	1946,4	3732,8	3892,8	687	1885,2	1965,2	3770,4	3930,4	781	1904,0	1984,0	3808,0	3968,0					
594	1866,6	1946,6	3733,2	3893,2	688	1885,4	1965,4	3770,8	3930,8	782	1904,2	1984,2	3808,4	3968,4					
595	1866,8	1946,8	3733,6	3893,6	689	1885,6	1965,6	3771,2	3931,2	783	1904,4	1984,4	3808,8	3968,8					
596	1867,0	1947,0	3734,0	3894,0	690	1885,8	1965,8	3771,6	3931,6	784	1904,6	1984,6	3809,2	3969,2					
597	1867,2	1947,2	3734,4	3894,4	691	1886,0	1966,0	3772,0	3932,0	785	1904,8	1984,8	3809,6	3969,6					
598	1867,4	1947,4	3734,8	3894,8	692	1886,2	1966,2	3772,4	3932,4	786	1905,0	1985,0	3810,0	3970,0					
599	1867,6	1947,6	3735,2	3895,2	693	1886,4	1966,4	3772,8	3932,8	787	1905,2	1985,2	3810,4	3970,4					
600	1867,8	1947,8	3735,6	3895,6	694	1886,6	1966,6	3773,2	3933,2	788	1905,4	1985,4	3810,8	3970,8					
601	1868,0	1948,0	3736,0	3896,0	695	1886,8	1966,8	3773,6	3933,6	789	1905,6	1985,6	3811,2	3971,2					
602	1868,2	1948,2	3736,4	3896,4	696	1887,0	1967,0	3774,0	3934,0	790	1905,8	1985,8	3811,6	3971,6					
603	1868,4	1948,4	3736,8	3896,8	697	1887,2	1967,2	3774,4	3934,4	791	1906,0	1986,0	3812,0	3972,0					
604	1868,6	1948,6	3737,2	3897,2	698	1887,4	1967,4	3774,8	3934,8	792	1906,2	1986,2	3812,4	3972,4					
605	1868,8	1948,8	3737,6	3897,6	699	1887,6	1967,6	3775,2	3935,2	793	1906,4	1986,4	3812,8	3972,8					

WCDMA V (850) frequencies

TX CH	RX CH	TX	RX	VCO TX	VCO RX
4132	4357	826.4	871.4	3305.6	3485.6
782	1007	826.5	871.5	3306.0	3486.0
4133	4358	826.6	871.6	3306.4	3486.4
4134	4359	826.8	871.8	3307.2	3487.2
4135	4360	827.0	872.0	3308.0	3488.0
4136	4361	827.2	872.2	3308.8	3488.8
4137	4362	827.4	872.4	3309.6	3489.6
787	1012	827.5	872.5	3310.0	3490.0
4138	4363	827.6	872.6	3310.4	3490.4
4139	4364	827.8	872.8	3311.2	3491.2
4140	4365	828.0	873.0	3312.0	3492.0
4141	4366	828.2	873.2	3312.8	3492.8
4142	4367	828.4	873.4	3313.6	3493.6
4143	4368	828.6	873.6	3314.4	3494.4
4144	4369	828.8	873.8	3315.2	3495.2
4145	4370	829.0	874.0	3316.0	3496.0
4146	4371	829.2	874.2	3316.8	3496.8
4147	4372	829.4	874.4	3317.6	3497.6
4148	4373	829.6	874.6	3318.4	3498.4
4149	4374	829.8	874.8	3319.2	3499.2
4150	4375	830.0	875.0	3320.0	3500.0
4151	4376	830.2	875.2	3320.8	3500.8
4152	4377	830.4	875.4	3321.6	3501.6
4153	4378	830.6	875.6	3322.4	3502.4
4154	4379	830.8	875.8	3323.2	3503.2
4155	4380	831.0	876.0	3324.0	3504.0
4156	4381	831.2	876.2	3324.8	3504.8
4157	4382	831.4	876.4	3325.6	3505.6
807	1032	831.5	876.5	3326.0	3506.0
4158	4383	831.6	876.6	3326.4	3506.4
4159	4384	831.8	876.8	3327.2	3507.2
4160	4385	832.0	877.0	3328.0	3508.0
4161	4386	832.2	877.2	3328.8	3508.8
4162	4387	832.4	877.4	3329.6	3509.6
812	1037	832.5	877.5	3330.0	3510.0
4163	4388	832.6	877.6	3330.4	3510.4
4164	4389	832.8	877.8	3331.2	3511.2
4165	4390	833.0	878.0	3332.0	3512.0
4166	4391	833.2	878.2	3332.8	3512.8
4167	4392	833.4	878.4	3333.6	3513.6
4168	4393	833.6	878.6	3334.4	3514.4
4169	4394	833.8	878.8	3335.2	3515.2
4170	4395	834.0	879.0	3336.0	3516.0
4171	4396	834.2	879.2	3336.8	3516.8
4172	4397	834.4	879.4	3337.6	3517.6
4173	4398	834.6	879.6	3338.4	3518.4
4174	4399	834.8	879.8	3339.2	3519.2
4175	4400	835.0	880.0	3340.0	3520.0
4176	4401	835.2	880.2	3340.8	3520.8
4177	4402	835.4	880.4	3341.6	3521.6
4178	4403	835.6	880.6	3342.4	3522.4
4179	4404	835.8	880.8	3343.2	3523.2
4180	4405	836.0	881.0	3344.0	3524.0
4181	4406	836.2	881.2	3344.8	3524.8
4182	4407	836.4	881.4	3345.6	3525.6
4183	4408	836.6	881.6	3346.4	3526.4
4184	4409	836.8	881.8	3347.2	3527.2
4185	4410	837.0	882.0	3348.0	3528.0
4186	4411	837.2	882.2	3348.8	3528.8
4187	4412	837.4	882.4	3349.6	3529.6
837	1062	837.5	882.5	3350.0	3530.0
4188	4413	837.6	882.6	3350.4	3530.4
4189	4414	837.8	882.8	3351.2	3531.2
4190	4415	838.0	883.0	3352.0	3532.0
4191	4416	838.2	883.2	3352.8	3532.8
4192	4417	838.4	883.4	3353.6	3533.6
4193	4418	838.6	883.6	3354.4	3534.4
4194	4419	838.8	883.8	3355.2	3535.2
4195	4420	839.0	884.0	3356.0	3536.0
4196	4421	839.2	884.2	3356.8	3536.8
4197	4422	839.4	884.4	3357.6	3537.6
4198	4423	839.6	884.6	3358.4	3538.4
4199	4424	839.8	884.8	3359.2	3539.2
4200	4425	840.0	885.0	3360.0	3540.0
4201	4426	840.2	885.2	3360.8	3540.8
4202	4427	840.4	885.4	3361.6	3541.6
4203	4428	840.6	885.6	3362.4	3542.4
4204	4429	840.8	885.8	3363.2	3543.2
4205	4430	841.0	886.0	3364.0	3544.0
4206	4431	841.2	886.2	3364.8	3544.8
4207	4432	841.4	886.4	3365.6	3545.6
4208	4433	841.6	886.6	3366.4	3546.4
4209	4434	841.8	886.8	3367.2	3547.2
4210	4435	842.0	887.0	3368.0	3548.0
4211	4436	842.2	887.2	3368.8	3548.8
4212	4437	842.4	887.4	3369.6	3549.6
862	1087	842.5	887.5	3370.0	3550.0
4213	4438	842.6	887.6	3370.4	3550.4
4214	4439	842.8	887.8	3371.2	3551.2
4215	4440	843.0	888.0	3372.0	3552.0
4216	4441	843.2	888.2	3372.8	3552.8
4217	4442	843.4	888.4	3373.6	3553.6
4218	4443	843.6	888.6	3374.4	3554.4
4219	4444	843.8	888.8	3375.2	3555.2
4220	4445	844.0	889.0	3376.0	3556.0
4221	4446	844.2	889.2	3376.8	3556.8
4222	4447	844.4	889.4	3377.6	3557.6
4223	4448	844.6	889.6	3378.4	3558.4
4224	4449	844.8	889.8	3379.2	3559.2
4225	4450	845.0	890.0	3380.0	3560.0
4226	4451	845.2	890.2	3380.8	3560.8
4227	4452	845.4	890.4	3381.6	3561.6
4228	4453	845.6	890.6	3382.4	3562.4
4229	4454	845.8	890.8	3383.2	3563.2
4230	4455	846.0	891.0	3384.0	3564.0
4231	4456	846.2	891.2	3384.8	3564.8
4232	4457	846.4	891.4	3385.6	3565.6
4233	4458	846.6	891.6	3386.4	3566.4

WCDMA VIII (900) frequencies

Uplink CH (TX)	Freq (MHz)	VCO (MHz)	Downlink CH (RX)	Freq (MHz)	VCO (MHz)
2712	882,4	3529,6	2937	927,4	3709,6
2713	882,6	3530,4	2938	927,6	3710,4
2714	882,8	3531,2	2939	927,8	3711,2
2715	883	3532	2940	928	3712
2716	883,2	3532,8	2941	928,2	3712,8
2717	883,4	3533,6	2942	928,4	3713,6
2718	883,6	3534,4	2943	928,6	3714,4
2719	883,8	3535,2	2944	928,8	3715,2
2720	884	3536	2945	929	3716
2721	884,2	3536,8	2946	929,2	3716,8
2722	884,4	3537,6	2947	929,4	3717,6
2723	884,6	3538,4	2948	929,6	3718,4
2724	884,8	3539,2	2949	929,8	3719,2
2725	885	3540	2950	930	3720
2726	885,2	3540,8	2951	930,2	3720,8
2727	885,4	3541,6	2952	930,4	3721,6
2728	885,6	3542,4	2953	930,6	3722,4
2729	885,8	3543,2	2954	930,8	3723,2
2730	886	3544	2955	931	3724
2731	886,2	3544,8	2956	931,2	3724,8
2732	886,4	3545,6	2957	931,4	3725,6
2733	886,6	3546,4	2958	931,6	3726,4
2734	886,8	3547,2	2959	931,8	3727,2
2735	887	3548	2960	932	3728
2736	887,2	3548,8	2961	932,2	3728,8
2737	887,4	3549,6	2962	932,4	3729,6
2738	887,6	3550,4	2963	932,6	3730,4
2739	887,8	3551,2	2964	932,8	3731,2
2740	888	3552	2965	933	3732
2741	888,2	3552,8	2966	933,2	3732,8
2742	888,4	3553,6	2967	933,4	3733,6
2743	888,6	3554,4	2968	933,6	3734,4
2744	888,8	3555,2	2969	933,8	3735,2

Uplink CH (TX)	Freq (MHz)	VCO (MHz)	Downlink CH (RX)	Freq (MHz)	VCO (MHz)
2745	889	3556	2970	934	3736
2746	889,2	3556,8	2971	934,2	3736,8
2747	889,4	3557,6	2972	934,4	3737,6
2748	889,6	3558,4	2973	934,6	3738,4
2749	889,8	3559,2	2974	934,8	3739,2
2750	890	3560	2975	935	3740
2751	890,2	3560,8	2976	935,2	3740,8
2752	890,4	3561,6	2977	935,4	3741,6
2753	890,6	3562,4	2978	935,6	3742,4
2754	890,8	3563,2	2979	935,8	3743,2
2755	891	3564	2980	936	3744
2756	891,2	3564,8	2981	936,2	3744,8
2757	891,4	3565,6	2982	936,4	3745,6
2758	891,6	3566,4	2983	936,6	3746,4
2759	891,8	3567,2	2984	936,8	3747,2
2760	892	3568	2985	937	3748
2761	892,2	3568,8	2986	937,2	3748,8
2762	892,4	3569,6	2987	937,4	3749,6
2763	892,6	3570,4	2988	937,6	3750,4
2764	892,8	3571,2	2989	937,8	3751,2
2765	893	3572	2990	938	3752
2766	893,2	3572,8	2991	938,2	3752,8
2767	893,4	3573,6	2992	938,4	3753,6
2768	893,6	3574,4	2993	938,6	3754,4
2769	893,8	3575,2	2994	938,8	3755,2
2770	894	3576	2995	939	3756
2771	894,2	3576,8	2996	939,2	3756,8
2772	894,4	3577,6	2997	939,4	3757,6
2773	894,6	3578,4	2998	939,6	3758,4
2774	894,8	3579,2	2999	939,8	3759,2
2775	895	3580	3000	940	3760
2776	895,2	3580,8	3001	940,2	3760,8
2777	895,4	3581,6	3002	940,4	3761,6
2778	895,6	3582,4	3003	940,6	3762,4
2779	895,8	3583,2	3004	940,8	3763,2

Uplink CH (TX)	Freq (MHz)	VCO (MHz)	Downlink CH (RX)	Freq (MHz)	VCO (MHz)
2780	896	3584	3005	941	3764
2781	896,2	3584,8	3006	941,2	3764,8
2782	896,4	3585,6	3007	941,4	3765,6
2783	896,6	3586,4	3008	941,6	3766,4
2784	896,8	3587,2	3009	941,8	3767,2
2785	897	3588	3010	942	3768
2786	897,2	3588,8	3011	942,2	3768,8
2787	897,4	3589,6	3012	942,4	3769,6
2788	897,6	3590,4	3013	942,6	3770,4
2789	897,8	3591,2	3014	942,8	3771,2
2790	898	3592	3015	943	3772
2791	898,2	3592,8	3016	943,2	3772,8
2792	898,4	3593,6	3017	943,4	3773,6
2793	898,6	3594,4	3018	943,6	3774,4
2794	898,8	3595,2	3019	943,8	3775,2
2795	899	3596	3020	944	3776
2796	899,2	3596,8	3021	944,2	3776,8
2797	899,4	3597,6	3022	944,4	3777,6
2798	899,6	3598,4	3023	944,6	3778,4
2799	899,8	3599,2	3024	944,8	3779,2
2800	900	3600	3025	945	3780
2801	900,2	3600,8	3026	945,2	3780,8
2802	900,4	3601,6	3027	945,4	3781,6
2803	900,6	3602,4	3028	945,6	3782,4
2804	900,8	3603,2	3029	945,8	3783,2
2805	901	3604	3030	946	3784
2806	901,2	3604,8	3031	946,2	3784,8
2807	901,4	3605,6	3032	946,4	3785,6
2808	901,6	3606,4	3033	946,6	3786,4
2809	901,8	3607,2	3034	946,8	3787,2
2810	902	3608	3035	947	3788
2811	902,2	3608,8	3036	947,2	3788,8
2812	902,4	3609,6	3037	947,4	3789,6
2813	902,6	3610,4	3038	947,6	3790,4
2814	902,8	3611,2	3039	947,8	3791,2

Uplink CH (TX)	Freq (MHz)	VCO (MHz)	Downlink CH (RX)	Freq (MHz)	VCO (MHz)
2815	903	3612	3040	948	3792
2816	903,2	3612,8	3041	948,2	3792,8
2817	903,4	3613,6	3042	948,4	3793,6
2818	903,6	3614,4	3043	948,6	3794,4
2819	903,8	3615,2	3044	948,8	3795,2
2820	904	3616	3045	949	3796
2821	904,2	3616,8	3046	949,2	3796,8
2822	904,4	3617,6	3047	949,4	3797,6
2823	904,6	3618,4	3048	949,6	3798,4
2824	904,8	3619,2	3049	949,8	3799,2
2825	905	3620	3050	950	3800
2826	905,2	3620,8	3051	950,2	3800,8
2827	905,4	3621,6	3052	950,4	3801,6
2828	905,6	3622,4	3053	950,6	3802,4
2829	905,8	3623,2	3054	950,8	3803,2
2830	906	3624	3055	951	3804
2831	906,2	3624,8	3056	951,2	3804,8
2832	906,4	3625,6	3057	951,4	3805,6
2833	906,6	3626,4	3058	951,6	3806,4
2834	906,8	3627,2	3059	951,8	3807,2
2835	907	3628	3060	952	3808
2836	907,2	3628,8	3061	952,2	3808,8
2837	907,4	3629,6	3062	952,4	3809,6
2838	907,6	3630,4	3063	952,6	3810,4
2839	907,8	3631,2	3064	952,8	3811,2
2840	908	3632	3065	953	3812
2841	908,2	3632,8	3066	953,2	3812,8
2842	908,4	3633,6	3067	953,4	3813,6
2843	908,6	3634,4	3068	953,6	3814,4
2844	908,8	3635,2	3069	953,8	3815,2
2845	909	3636	3070	954	3816
2846	909,2	3636,8	3071	954,2	3816,8
2847	909,4	3637,6	3072	954,4	3817,6
2848	909,6	3638,4	3073	954,6	3818,4
2849	909,8	3639,2	3074	954,8	3819,2

Uplink CH (TX)	Freq (MHz)	VCO (MHz)	Downlink CH (RX)	Freq (MHz)	VCO (MHz)
2850	910	3640	3075	955	3820
2851	910,2	3640,8	3076	955,2	3820,8
2852	910,4	3641,6	3077	955,4	3821,6
2853	910,6	3642,4	3078	955,6	3822,4
2854	910,8	3643,2	3079	955,8	3823,2
2855	911	3644	3080	956	3824
2856	911,2	3644,8	3081	956,2	3824,8
2857	911,4	3645,6	3082	956,4	3825,6
2858	911,6	3646,4	3083	956,6	3826,4
2859	911,8	3647,2	3084	956,8	3827,2
2860	912	3648	3085	957	3828
2861	912,2	3648,8	3086	957,2	3828,8
2862	912,4	3649,6	3087	957,4	3829,6
2863	912,6	3650,4	3088	957,6	3830,4

WCDMA II (1900) frequencies

TX CH	RX CH	TX	RX	VCO TX	VCO RX
9262	9662	1852.4	1932.4	3704.8	3864.8
12	412	1852.5	1932.5	3705.0	3865.0
9263	9663	1852.6	1932.6	3705.2	3865.2
9264	9664	1852.8	1932.8	3705.6	3865.6
9265	9665	1853.0	1933.0	3706.0	3866.0
9266	9666	1853.2	1933.2	3706.4	3866.4
9267	9667	1853.4	1933.4	3706.8	3866.8
9268	9668	1853.6	1933.6	3707.2	3867.2
9269	9669	1853.8	1933.8	3707.6	3867.6
9270	9670	1854.0	1934.0	3708.0	3868.0
9271	9671	1854.2	1934.2	3708.4	3868.4
9272	9672	1854.4	1934.4	3708.8	3868.8
9273	9673	1854.6	1934.6	3709.2	3869.2
9274	9674	1854.8	1934.8	3709.6	3869.6
9275	9675	1855.0	1935.0	3710.0	3870.0
9276	9676	1855.2	1935.2	3710.4	3870.4
9277	9677	1855.4	1935.4	3710.8	3870.8
9278	9678	1855.6	1935.6	3711.2	3871.2
9279	9679	1855.8	1935.8	3711.6	3871.6
9280	9680	1856.0	1936.0	3712.0	3872.0
9281	9681	1856.2	1936.2	3712.4	3872.4
9282	9682	1856.4	1936.4	3712.8	3872.8
9283	9683	1856.6	1936.6	3713.2	3873.2
9284	9684	1856.8	1936.8	3713.6	3873.6
9285	9685	1857.0	1937.0	3714.0	3874.0
9286	9686	1857.2	1937.2	3714.4	3874.4
9287	9687	1857.4	1937.4	3714.8	3874.8
37	437	1857.5	1937.5	3715.0	3875.0
9288	9688	1857.6	1937.6	3715.2	3875.2
9289	9689	1857.8	1937.8	3715.6	3875.6
9290	9690	1858.0	1938.0	3716.0	3876.0
9291	9691	1858.2	1938.2	3716.4	3876.4
9292	9692	1858.4	1938.4	3716.8	3876.8
9293	9693	1858.6	1938.6	3717.2	3877.2
9294	9694	1858.8	1938.8	3717.6	3877.6
9295	9695	1859.0	1939.0	3718.0	3878.0
9296	9696	1859.2	1939.2	3718.4	3878.4
9297	9697	1859.4	1939.4	3718.8	3878.8
9298	9698	1859.6	1939.6	3719.2	3879.2
9299	9699	1859.8	1939.8	3719.6	3879.6
9300	9700	1860.0	1940.0	3720.0	3880.0
9301	9701	1860.2	1940.2	3720.4	3880.4
9302	9702	1860.4	1940.4	3720.8	3880.8
9303	9703	1860.6	1940.6	3721.2	3881.2
9304	9704	1860.8	1940.8	3721.6	3881.6
9305	9705	1861.0	1941.0	3722.0	3882.0
9306	9706	1861.2	1941.2	3722.4	3882.4
9307	9707	1861.4	1941.4	3722.8	3882.8
9308	9708	1861.6	1941.6	3723.2	3883.2
9309	9709	1861.8	1941.8	3723.6	3883.6
9310	9710	1862.0	1942.0	3724.0	3884.0
9311	9711	1862.2	1942.2	3724.4	3884.4
9312	9712	1862.4	1942.4	3724.8	3884.8
62	462	1862.5	1942.5	3725.0	3885.0
9313	9713	1862.6	1942.6	3725.2	3885.2
9314	9714	1862.8	1942.8	3725.6	3885.6
9315	9715	1863.0	1943.0	3726.0	3886.0
9316	9716	1863.2	1943.2	3726.4	3886.4
9317	9717	1863.4	1943.4	3726.8	3886.8
9318	9718	1863.6	1943.6	3727.2	3887.2
9319	9719	1863.8	1943.8	3727.6	3887.6
9320	9720	1864.0	1944.0	3728.0	3888.0
9321	9721	1864.2	1944.2	3728.4	3888.4
9322	9722	1864.4	1944.4	3728.8	3888.8
9323	9723	1864.6	1944.6	3729.2	3889.2
9324	9724	1864.8	1944.8	3729.6	3889.6
9325	9725	1865.0	1945.0	3730.0	3890.0
9326	9726	1865.2	1945.2	3730.4	3890.4
9327	9727	1865.4	1945.4	3730.8	3890.8
9328	9728	1865.6	1945.6	3731.2	3891.2
9329	9729	1865.8	1945.8	3731.6	3891.6
9330	9730	1866.0	1946.0	3732.0	3892.0
9331	9731	1866.2	1946.2	3732.4	3892.4
9332	9732	1866.4	1946.4	3732.8	3892.8
9333	9733	1866.6	1946.6	3733.2	3893.2
9334	9734	1866.8	1946.8	3733.6	3893.6
9335	9735	1867.0	1947.0	3734.0	3894.0
9336	9736	1867.2	1947.2	3734.4	3894.4
9337	9737	1867.4	1947.4	3734.8	3894.8
87	487	1867.5	1947.5	3735.0	3895.0
9338	9738	1867.6	1947.6	3735.2	3895.2
9339	9739	1867.8	1947.8	3735.6	3895.6
9340	9740	1868.0	1948.0	3736.0	3896.0
9341	9741	1868.2	1948.2	3736.4	3896.4
9342	9742	1868.4	1948.4	3736.8	3896.8
9343	9743	1868.6	1948.6	3737.2	3897.2
9344	9744	1868.8	1948.8	3737.6	3897.6
9345	9745	1869.0	1949.0	3738.0	3898.0
9346	9746	1869.2	1949.2	3738.4	3898.4
9347	9747	1869.4	1949.4	3738.8	3898.8
9348	9748	1869.6	1949.6	3739.2	3899.2
9349	9749	1869.8	1949.8	3739.6	3899.6
9350	9750	1870.0	1950.0	3740.0	3900.0
9351	9751	1870.2	1950.2	3740.4	3900.4
9352	9752	1870.4	1950.4	3740.8	3900.8
9353	9753	1870.6	1950.6	3741.2	3901.2
9354	9754	1870.8	1950.8	3741.6	3901.6

TX CH	RX CH	TX	RX	VCO TX	VCO RX
9355	9755	1871.0	1951.0	3742.0	3902.0
9356	9756	1871.2	1951.2	3742.4	3902.4
9357	9757	1871.4	1951.4	3742.8	3902.8
9358	9758	1871.6	1951.6	3743.2	3903.2
9359	9759	1871.8	1951.8	3743.6	3903.6
9360	9760	1872.0	1952.0	3744.0	3904.0
9361	9761	1872.2	1952.2	3744.4	3904.4
9362	9762	1872.4	1952.4	3744.8	3904.8
112	512	1872.5	1952.5	3745.0	3905.0
9363	9763	1872.6	1952.6	3745.2	3905.2
9364	9764	1872.8	1952.8	3745.6	3905.6
9365	9765	1873.0	1953.0	3746.0	3906.0
9366	9766	1873.2	1953.2	3746.4	3906.4
9367	9767	1873.4	1953.4	3746.8	3906.8
9368	9768	1873.6	1953.6	3747.2	3907.2
9369	9769	1873.8	1953.8	3747.6	3907.6
9370	9770	1874.0	1954.0	3748.0	3908.0
9371	9771	1874.2	1954.2	3748.4	3908.4
9372	9772	1874.4	1954.4	3748.8	3908.8
9373	9773	1874.6	1954.6	3749.2	3909.2
9374	9774	1874.8	1954.8	3749.6	3909.6
9375	9775	1875.0	1955.0	3750.0	3910.0
9376	9776	1875.2	1955.2	3750.4	3910.4
9377	9777	1875.4	1955.4	3750.8	3910.8
9378	9778	1875.6	1955.6	3751.2	3911.2
9379	9779	1875.8	1955.8	3751.6	3911.6
9380	9780	1876.0	1956.0	3752.0	3912.0
9381	9781	1876.2	1956.2	3752.4	3912.4
9382	9782	1876.4	1956.4	3752.8	3912.8
9383	9783	1876.6	1956.6	3753.2	3913.2
9384	9784	1876.8	1956.8	3753.6	3913.6
9385	9785	1877.0	1957.0	3754.0	3914.0
9386	9786	1877.2	1957.2	3754.4	3914.4
9387	9787	1877.4	1957.4	3754.8	3914.8
137	537	1877.5	1957.5	3755.0	3915.0
9388	9788	1877.6	1957.6	3755.2	3915.2
9389	9789	1877.8	1957.8	3755.6	3915.6
9390	9790	1878.0	1958.0	3756.0	3916.0
9391	9791	1878.2	1958.2	3756.4	3916.4
9392	9792	1878.4	1958.4	3756.8	3916.8
9393	9793	1878.6	1958.6	3757.2	3917.2
9394	9794	1878.8	1958.8	3757.6	3917.6
9395	9795	1879.0	1959.0	3758.0	3918.0
9396	9796	1879.2	1959.2	3758.4	3918.4
9397	9797	1879.4	1959.4	3758.8	3918.8
9398	9798	1879.6	1959.6	3759.2	3919.2
9399	9799	1879.8	1959.8	3759.6	3919.6
9400	9800	1880.0	1960.0	3760.0	3920.0
9401	9801	1880.2	1960.2	3760.4	3920.4
9402	9802	1880.4	1960.4	3760.8	3920.8
9403	9803	1880.6	1960.6	3761.2	3921.2
9404	9804	1880.8	1960.8	3761.6	3921.6
9405	9805	1881.0	1961.0	3762.0	3922.0
9406	9806	1881.2	1961.2	3762.4	3922.4
9407	9807	1881.4	1961.4	3762.8	3922.8
9408	9808	1881.6	1961.6	3763.2	3923.2
9409	9809	1881.8	1961.8	3763.6	3923.6
9410	9810	1882.0	1962.0	3764.0	3924.0
9411	9811	1882.2	1962.2	3764.4	3924.4
9412	9812	1882.4	1962.4	3764.8	3924.8
162	562	1882.5	1962.5	3765.0	3925.0
9413	9813	1882.6	1962.6	3765.2	3925.2
9414	9814	1882.8	1962.8	3765.6	3925.6
9415	9815	1883.0	1963.0	3766.0	3926.0
9416	9816	1883.2	1963.2	3766.4	3926.4
9417	9817	1883.4	1963.4	3766.8	3926.8
9418	9818	1883.6	1963.6	3767.2	3927.2
9419	9819	1883.8	1963.8	3767.6	3927.6
9420	9820	1884.0	1964.0	3768.0	3928.0
9421	9821	1884.2	1964.2	3768.4	3928.4
9422	9822	1884.4	1964.4	3768.8	3928.8
9423	9823	1884.6	1964.6	3769.2	3929.2
9424	9824	1884.8	1964.8	3769.6	3929.6
9425	9825	1885.0	1965.0	3770.0	3930.0
9426	9826	1885.2	1965.2	3770.4	3930.4
9427	9827	1885.4	1965.4	3770.8	3930.8
9428	9828	1885.6	1965.6	3771.2	3931.2
9429	9829	1885.8	1965.8	3771.6	3931.6
9430	9830	1886.0	1966.0	3772.0	3932.0
9431	9831	1886.2	1966.2	3772.4	3932.4
9432	9832	1886.4	1966.4	3772.8	3932.8
9433	9833	1886.6	1966.6	3773.2	3933.2
9434	9834	1886.8	1966.8	3773.6	3933.6
9435	9835	1887.0	1967.0	3774.0	3934.0
9436	9836	1887.2	1967.2	3774.4	3934.4
9437	9837	1887.4	1967.4	3774.8	3934.8
187	587	1887.5	1967.5	3775.0	3935.0
9438	9838	1887.6	1967.6	3775.2	3935.2
9439	9839	1887.8	1967.8	3775.6	3935.6
9440	9840	1888.0	1968.0	3776.0	3936.0
9441	9841	1888.2	1968.2	3776.4	3936.4
9442	9842	1888.4	1968.4	3776.8	3936.8
9443	9843	1888.6	1968.6	3777.2	3937.2
9444	9844	1888.8	1968.8	3777.6	3937.6
9445	9845	1889.0	1969.0	3778.0	3938.0
9446	9846	1889.2	1969.2	3778.4	3938.4
9447	9847	1889.4	1969.4	3778.8	3938.8

TX CH	RX CH	TX	RX	VCO TX	VCO RX
9448	9848	1889.6	1969.6	3779.2	3939.2
9449	9849	1889.8	1969.8	3779.6	3939.6
9450	9850	1890.0	1970.0	3780.0	3940.0
9451	9851	1890.2	1970.2	3780.4	3940.4
9452	9852	1890.4	1970.4	3780.8	3940.8
9453	9853	1890.6	1970.6	3781.2	3941.2
9454	9854	1890.8	1970.8	3781.6	3941.6
9455	9855	1891.0	1971.0	3782.0	3942.0
9456	9856	1891.2	1971.2	3782.4	3942.4
9457	9857	1891.4	1971.4	3782.8	3942.8
9458	9858	1891.6	1971.6	3783.2	3943.2
9459	9859	1891.8	1971.8	3783.6	3943.6
9460	9860	1892.0	1972.0	3784.0	3944.0
9461	9861	1892.2	1972.2	3784.4	3944.4
9462	9862	1892.4	1972.4	3784.8	3944.8
212	612	1892.5	1972.5	3785.0	3945.0
9463	9863	1892.6	1972.6	3785.2	3945.2
9464	9864	1892.8	1972.8	3785.6	3945.6
9465	9865	1893.0	1973.0	3786.0	3946.0
9466	9866	1893.2	1973.2	3786.4	3946.4
9467	9867	1893.4	1973.4	3786.8	3946.8
9468	9868	1893.6	1973.6	3787.2	3947.2
9469	9869	1893.8	1973.8	3787.6	3947.6
9470	9870	1894.0	1974.0	3788.0	3948.0
9471	9871	1894.2	1974.2	3788.4	3948.4
9472	9872	1894.4	1974.4	3788.8	3948.8
9473	9873	1894.6	1974.6	3789.2	3949.2
9474	9874	1894.8	1974.8	3789.6	3949.6
9475	9875	1895.0	1975.0	3790.0	3950.0
9476	9876	1895.2	1975.2	3790.4	3950.4
9477	9877	1895.4	1975.4	3790.8	3950.8
9478	9878	1895.6	1975.6	3791.2	3951.2
9479	9879	1895.8	1975.8	3791.6	3951.6
9480	9880	1896.0	1976.0	3792.0	3952.0
9481	9881	1896.2	1976.2	3792.4	3952.4
9482	9882	1896.4	1976.4	3792.8	3952.8
9483	9883	1896.6	1976.6	3793.2	3953.2
9484	9884	1896.8	1976.8	3793.6	3953.6
9485	9885	1897.0	1977.0	3794.0	3954.0
9486	9886	1897.2	1977.2	3794.4	3954.4
9487	9887	1897.4	1977.4	3794.8	3954.8
237	637	1897.5	1977.5	3795.0	3955.0
9488	9888	1897.6	1977.6	3795.2	3955.2
9489	9889	1897.8	1977.8	3795.6	3955.6
9490	9890	1898.0	1978.0	3796.0	3956.0
9491	9891	1898.2	1978.2	3796.4	3956.4
9492	9892	1898.4	1978.4	3796.8	3956.8
9493	9893	1898.6	1978.6	3797.2	3957.2
9494	9894	1898.8	1978.8	3797.6	3957.6
9495	9895	1899.0	1979.0	3798.0	3958.0
9496	9896	1899.2	1979.2	3798.4	3958.4
9497	9897	1899.4	1979.4	3798.8	3958.8
9498	9898	1899.6	1979.6	3799.2	3959.2
9499	9899	1899.8	1979.8	3799.6	3959.6
9500	9900	1900.0	1980.0	3800.0	3960.0
9501	9901	1900.2	1980.2	3800.4	3960.4
9502	9902	1900.4	1980.4	3800.8	3960.8
9503	9903	1900.6	1980.6	3801.2	3961.2
9504	9904	1900.8	1980.8	3801.6	3961.6
9505	9905	1901.0	1981.0	3802.0	3962.0
9506	9906	1901.2	1981.2	3802.4	3962.4
9507	9907	1901.4	1981.4	3802.8	3962.8
9508	9908	1901.6	1981.6	3803.2	3963.2
9509	9909	1901.8	1981.8	3803.6	3963.6
9510	9910	1902.0	1982.0	3804.0	3964.0
9511	9911	1902.2	1982.2	3804.4	3964.4
9512	9912	1902.4	1982.4	3804.8	3964.8
262	662	1902.5	1982.5	3805.0	3965.0
9513	9913	1902.6	1982.6	3805.2	3965.2
9514	9914	1902.8	1982.8	3805.6	3965.6
9515	9915	1903.0	1983.0	3806.0	3966.0
9516	9916	1903.2	1983.2	3806.4	3966.4
9517	9917	1903.4	1983.4	3806.8	3966.8
9518	9918	1903.6	1983.6	3807.2	3967.2
9519	9919	1903.8	1983.8	3807.6	3967.6
9520	9920	1904.0	1984.0	3808.0	3968.0
9521	9921	1904.2	1984.2	3808.4	3968.4
9522	9922	1904.4	1984.4	3808.8	3968.8
9523	9923	1904.6	1984.6	3809.2	3969.2
9524	9924	1904.8	1984.8	3809.6	3969.6
9525	9925	1905.0	1985.0	3810.0	3970.0
9526	9926	1905.2	1985.2	3810.4	3970.4
9527	9927	1905.4	1985.4	3810.8	3970.8
9528	9928	1905.6	1985.6	3811.2	3971.2
9529	9929	1905.8	1985.8	3811.6	3971.6
9530	9930	1906.0	1986.0	3812.0	3972.0
9531	9931	1906.2	1986.2	3812.4	3972.4
9532	9932	1906.4	1986.4	3812.8	3972.8
9533	9933	1906.6	1986.6	3813.2	3973.2
9534	9934	1906.8	1986.8	3813.6	3973.6
9535	9935	1907.0	1987.0	3814.0	3974.0
9536	9936	1907.2	1987.2	3814.4	3974.4
9537	9937	1907.4	1987.4	3814.8	3974.8
287	687	1907.5	1987.5	3815.0	3975.0
9538	9938	1907.6	1987.6	3815.2	3975.2

WCDMA 2100 Rx frequencies

Ch	RX	VCO RX	Ch	RX	VCO RX	Ch	RX	VCO RX	Ch	RX	VCO RX	Ch	RX	VCO RX
10562	2112.4	4224.8	10625	2125	4250	10688	2137.6	4275.2	10751	2150.2	4300.4	10814	2162.8	4325.6
10563	2112.6	4225.2	10626	2125.2	4250.4	10689	2137.8	4275.6	10752	2150.4	4300.8	10815	2163	4326
10564	2112.8	4225.6	10627	2125.4	4250.8	10690	2138	4276	10753	2150.6	4301.2	10816	2163.2	4326.4
10565	2113	4226	10628	2125.6	4251.2	10691	2138.2	4276.4	10754	2150.8	4301.6	10817	2163.4	4326.8
10566	2113.2	4226.4	10629	2125.8	4251.6	10692	2138.4	4276.8	10755	2151	4302	10818	2163.6	4327.2
10567	2113.4	4226.8	10630	2126	4252	10693	2138.6	4277.2	10756	2151.2	4302.4	10819	2163.8	4327.6
10568	2113.6	4227.2	10631	2126.2	4252.4	10694	2138.8	4277.6	10757	2151.4	4302.8	10820	2164	4328
10569	2113.8	4227.6	10632	2126.4	4252.8	10695	2139	4278	10758	2151.6	4303.2	10821	2164.2	4328.4
10570	2114	4228	10633	2126.6	4253.2	10696	2139.2	4278.4	10759	2151.8	4303.6	10822	2164.4	4328.8
10571	2114.2	4228.4	10634	2126.8	4253.6	10697	2139.4	4278.8	10760	2152	4304	10823	2164.6	4329.2
10572	2114.4	4228.8	10635	2127	4254	10698	2139.6	4279.2	10761	2152.2	4304.4	10824	2164.8	4329.6
10573	2114.6	4229.2	10636	2127.2	4254.4	10699	2139.8	4279.6	10762	2152.4	4304.8	10825	2165	4330
10574	2114.8	4229.6	10637	2127.4	4254.8	10700	2140	4280	10763	2152.6	4305.2	10826	2165.2	4330.4
10575	2115	4230	10638	2127.6	4255.2	10701	2140.2	4280.4	10764	2152.8	4305.6	10827	2165.4	4330.8
10576	2115.2	4230.4	10639	2127.8	4255.6	10702	2140.4	4280.8	10765	2153	4306	10828	2165.6	4331.2
10577	2115.4	4230.8	10640	2128	4256	10703	2140.6	4281.2	10766	2153.2	4306.4	10829	2165.8	4331.6
10578	2115.6	4231.2	10641	2128.2	4256.4	10704	2140.8	4281.6	10767	2153.4	4306.8	10830	2166	4332
10579	2115.8	4231.6	10642	2128.4	4256.8	10705	2141	4282	10768	2153.6	4307.2	10831	2166.2	4332.4
10580	2116	4232	10643	2128.6	4257.2	10706	2141.2	4282.4	10769	2153.8	4307.6	10832	2166.4	4332.8
10581	2116.2	4232.4	10644	2128.8	4257.6	10707	2141.4	4282.8	10770	2154	4308	10833	2166.6	4333.2
10582	2116.4	4232.8	10645	2129	4258	10708	2141.6	4283.2	10771	2154.2	4308.4	10834	2166.8	4333.6
10583	2116.6	4233.2	10646	2129.2	4258.4	10709	2141.8	4283.6	10772	2154.4	4308.8	10835	2167	4334
10584	2116.8	4233.6	10647	2129.4	4258.8	10710	2142	4284	10773	2154.6	4309.2	10836	2167.2	4334.4
10585	2117	4234	10648	2129.6	4259.2	10711	2142.2	4284.4	10774	2154.8	4309.6	10837	2167.4	4334.8
10586	2117.2	4234.4	10649	2129.8	4259.6	10712	2142.4	4284.8	10775	2155	4310	10838	2167.6	4335.2
10587	2117.4	4234.8	10650	2130	4260	10713	2142.6	4285.2	10776	2155.2	4310.4			
10588	2117.6	4235.2	10651	2130.2	4260.4	10714	2142.8	4285.6	10777	2155.4	4310.8			
10589	2117.8	4235.6	10652	2130.4	4260.8	10715	2143	4286	10778	2155.6	4311.2			
10590	2118	4236	10653	2130.6	4261.2	10716	2143.2	4286.4	10779	2155.8	4311.6			
10591	2118.2	4236.4	10654	2130.8	4261.6	10717	2143.4	4286.8	10780	2156	4312			
10592	2118.4	4236.8	10655	2131	4262	10718	2143.6	4287.2	10781	2156.2	4312.4			
10593	2118.6	4237.2	10656	2131.2	4262.4	10719	2143.8	4287.6	10782	2156.4	4312.8			
10594	2118.8	4237.6	10657	2131.4	4262.8	10720	2144	4288	10783	2156.6	4313.2			
10595	2119	4238	10658	2131.6	4263.2	10721	2144.2	4288.4	10784	2156.8	4313.6			
10596	2119.2	4238.4	10659	2131.8	4263.6	10722	2144.4	4288.8	10785	2157	4314			
10597	2119.4	4238.8	10660	2132	4264	10723	2144.6	4289.2	10786	2157.2	4314.4			
10598	2119.6	4239.2	10661	2132.2	4264.4	10724	2144.8	4289.6	10787	2157.4	4314.8			
10599	2119.8	4239.6	10662	2132.4	4264.8	10725	2145	4290	10788	2157.6	4315.2			
10600	2120	4240	10663	2132.6	4265.2	10726	2145.2	4290.4	10789	2157.8	4315.6			
10601	2120.2	4240.4	10664	2132.8	4265.6	10727	2145.4	4290.8	10790	2158	4316			
10602	2120.4	4240.8	10665	2133	4266	10728	2145.6	4291.2	10791	2158.2	4316.4			
10603	2120.6	4241.2	10666	2133.2	4266.4	10729	2145.8	4291.6	10792	2158.4	4316.8			
10604	2120.8	4241.6	10667	2133.4	4266.8	10730	2146	4292	10793	2158.6	4317.2			
10605	2121	4242	10668	2133.6	4267.2	10731	2146.2	4292.4	10794	2158.8	4317.6			
10606	2121.2	4242.4	10669	2133.8	4267.6	10732	2146.4	4292.8	10795	2159	4318			
10607	2121.4	4242.8	10670	2134	4268	10733	2146.6	4293.2	10796	2159.2	4318.4			
10608	2121.6	4243.2	10671	2134.2	4268.4	10734	2146.8	4293.6	10797	2159.4	4318.8			
10609	2121.8	4243.6	10672	2134.4	4268.8	10735	2147	4294	10798	2159.6	4319.2			
10610	2122	4244	10673	2134.6	4269.2	10736	2147.2	4294.4	10799	2159.8	4319.6			
10611	2122.2	4244.4	10674	2134.8	4269.6	10737	2147.4	4294.8	10800	2160	4320			
10612	2122.4	4244.8	10675	2135	4270	10738	2147.6	4295.2	10801	2160.2	4320.4			
10613	2122.6	4245.2	10676	2135.2	4270.4	10739	2147.8	4295.6	10802	2160.4	4320.8			
10614	2122.8	4245.6	10677	2135.4	4270.8	10740	2148	4296	10803	2160.6	4321.2			
10615	2123	4246	10678	2135.6	4271.2	10741	2148.2	4296.4	10804	2160.8	4321.6			
10616	2123.2	4246.4	10679	2135.8	4271.6	10742	2148.4	4296.8	10805	2161	4322			
10617	2123.4	4246.8	10680	2136	4272	10743	2148.6	4297.2	10806	2161.2	4322.4			
10618	2123.6	4247.2	10681	2136.2	4272.4	10744	2148.8	4297.6	10807	2161.4	4322.8			
10619	2123.8	4247.6	10682	2136.4	4272.8	10745	2149	4298	10808	2161.6	4323.2			
10620	2124	4248	10683	2136.6	4273.2	10746	2149.2	4298.4	10809	2161.8	4323.6			
10621	2124.2	4248.4	10684	2136.8	4273.6	10747	2149.4	4298.8	10810	2162	4324			
10622	2124.4	4248.8	10685	2137	4274	10748	2149.6	4299.2	10811	2162.2	4324.4			
10623	2124.6	4249.2	10686	2137.2	4274.4	10749	2149.8	4299.6	10812	2162.4	4324.8			
10624	2124.8	4249.6	10687	2137.4	4274.8	10750	2150	4300	10813	2162.6	4325.2			

WCDMA 2100 Tx frequencies

Ch	Tx	VCO Tx	Ch	Tx	VCO Tx	Ch	Tx	VCO Tx	Ch	Tx	VCO Tx	Ch	Tx	VCO Tx
9612	1922.4	3844.8	9671	1934.2	3868.4	9730	1946	3892	9789	1957.8	3915.6	9848	1969.6	3939.2
9613	1922.6	3845.2	9672	1934.4	3868.8	9731	1946.2	3892.4	9790	1958	3916	9849	1969.8	3939.6
9614	1922.8	3845.6	9673	1934.6	3869.2	9732	1946.4	3892.8	9791	1958.2	3916.4	9850	1970	3940
9615	1923	3846	9674	1934.8	3869.6	9733	1946.6	3893.2	9792	1958.4	3916.8	9851	1970.2	3940.4
9616	1923.2	3846.4	9675	1935	3870	9734	1946.8	3893.6	9793	1958.6	3917.2	9852	1970.4	3940.8
9617	1923.4	3846.8	9676	1935.2	3870.4	9735	1947	3894	9794	1958.8	3917.6	9853	1970.6	3941.2
9618	1923.6	3847.2	9677	1935.4	3870.8	9736	1947.2	3894.4	9795	1959	3918	9854	1970.8	3941.6
9619	1923.8	3847.6	9678	1935.6	3871.2	9737	1947.4	3894.8	9796	1959.2	3918.4	9855	1971	3942
9620	1924	3848	9679	1935.8	3871.6	9738	1947.6	3895.2	9797	1959.4	3918.8	9856	1971.2	3942.4
9621	1924.2	3848.4	9680	1936	3872	9739	1947.8	3895.6	9798	1959.6	3919.2	9857	1971.4	3942.8
9622	1924.4	3848.8	9681	1936.2	3872.4	9740	1948	3896	9799	1959.8	3919.6	9858	1971.6	3943.2
9623	1924.6	3849.2	9682	1936.4	3872.8	9741	1948.2	3896.4	9800	1960	3920	9859	1971.8	3943.6
9624	1924.8	3849.6	9683	1936.6	3873.2	9742	1948.4	3896.8	9801	1960.2	3920.4	9860	1972	3944
9625	1925	3850	9684	1936.8	3873.6	9743	1948.6	3897.2	9802	1960.4	3920.8	9861	1972.2	3944.4
9626	1925.2	3850.4	9685	1937	3874	9744	1948.8	3897.6	9803	1960.6	3921.2	9862	1972.4	3944.8
9627	1925.4	3850.8	9686	1937.2	3874.4	9745	1949	3898	9804	1960.8	3921.6	9863	1972.6	3945.2
9628	1925.6	3851.2	9687	1937.4	3874.8	9746	1949.2	3898.4	9805	1961	3922	9864	1972.8	3945.6
9629	1925.8	3851.6	9688	1937.6	3875.2	9747	1949.4	3898.8	9806	1961.2	3922.4	9865	1973	3946
9630	1926	3852	9689	1937.8	3875.6	9748	1949.6	3899.2	9807	1961.4	3922.8	9866	1973.2	3946.4
9631	1926.2	3852.4	9690	1938	3876	9749	1949.8	3899.6	9808	1961.6	3923.2	9867	1973.4	3946.8
9632	1926.4	3852.8	9691	1938.2	3876.4	9750	1950	3900	9809	1961.8	3923.6	9868	1973.6	3947.2
9633	1926.6	3853.2	9692	1938.4	3876.8	9751	1950.2	3900.4	9810	1962	3924	9869	1973.8	3947.6
9634	1926.8	3853.6	9693	1938.6	3877.2	9752	1950.4	3900.8	9811	1962.2	3924.4	9870	1974	3948
9635	1927	3854	9694	1938.8	3877.6	9753	1950.6	3901.2	9812	1962.4	3924.8	9871	1974.2	3948.4
9636	1927.2	3854.4	9695	1939	3878	9754	1950.8	3901.6	9813	1962.6	3925.2	9872	1974.4	3948.8
9637	1927.4	3854.8	9696	1939.2	3878.4	9755	1951	3902	9814	1962.8	3925.6	9873	1974.6	3949.2
9638	1927.6	3855.2	9697	1939.4	3878.8	9756	1951.2	3902.4	9815	1963	3926	9874	1974.8	3949.6
9639	1927.8	3855.6	9698	1939.6	3879.2	9757	1951.4	3902.8	9816	1963.2	3926.4	9875	1975	3950
9640	1928	3856	9699	1939.8	3879.6	9758	1951.6	3903.2	9817	1963.4	3926.8	9876	1975.2	3950.4
9641	1928.2	3856.4	9700	1940	3880	9759	1951.8	3903.6	9818	1963.6	3927.2	9877	1975.4	3950.8
9642	1928.4	3856.8	9701	1940.2	3880.4	9760	1952	3904	9819	1963.8	3927.6	9878	1975.6	3951.2
9643	1928.6	3857.2	9702	1940.4	3880.8	9761	1952.2	3904.4	9820	1964	3928	9879	1975.8	3951.6
9644	1928.8	3857.6	9703	1940.6	3881.2	9762	1952.4	3904.8	9821	1964.2	3928.4	9880	1976	3952
9645	1929	3858	9704	1940.8	3881.6	9763	1952.6	3905.2	9822	1964.4	3928.8	9881	1976.2	3952.4
9646	1929.2	3858.4	9705	1941	3882	9764	1952.8	3905.6	9823	1964.6	3929.2	9882	1976.4	3952.8
9647	1929.4	3858.8	9706	1941.2	3882.4	9765	1953	3906	9824	1964.8	3929.6	9883	1976.6	3953.2
9648	1929.6	3859.2	9707	1941.4	3882.8	9766	1953.2	3906.4	9825	1965	3930	9884	1976.8	3953.6
9649	1929.8	3859.6	9708	1941.6	3883.2	9767	1953.4	3906.8	9826	1965.2	3930.4	9885	1977	3954
9650	1930	3860	9709	1941.8	3883.6	9768	1953.6	3907.2	9827	1965.4	3930.8	9886	1977.2	3954.4
9651	1930.2	3860.4	9710	1942	3884	9769	1953.8	3907.6	9828	1965.6	3931.2	9887	1977.4	3954.8
9652	1930.4	3860.8	9711	1942.2	3884.4	9770	1954	3908	9829	1965.8	3931.6	9888	1977.6	3955.2
9653	1930.6	3861.2	9712	1942.4	3884.8	9771	1954.2	3908.4	9830	1966	3932			
9654	1930.8	3861.6	9713	1942.6	3885.2	9772	1954.4	3908.8	9831	1966.2	3932.4			
9655	1931	3862	9714	1942.8	3885.6	9773	1954.6	3909.2	9832	1966.4	3932.8			
9656	1931.2	3862.4	9715	1943	3886	9774	1954.8	3909.6	9833	1966.6	3933.2			
9657	1931.4	3862.8	9716	1943.2	3886.4	9775	1955	3910	9834	1966.8	3933.6			
9658	1931.6	3863.2	9717	1943.4	3886.8	9776	1955.2	3910.4	9835	1967	3934			
9659	1931.8	3863.6	9718	1943.6	3887.2	9777	1955.4	3910.8	9836	1967.2	3934.4			
9660	1932	3864	9719	1943.8	3887.6	9778	1955.6	3911.2	9837	1967.4	3934.8			
9661	1932.2	3864.4	9720	1944	3888	9779	1955.8	3911.6	9838	1967.6	3935.2			
9662	1932.4	3864.8	9721	1944.2	3888.4	9780	1956	3912	9839	1967.8	3935.6			
9663	1932.6	3865.2	9722	1944.4	3888.8	9781	1956.2	3912.4	9840	1968	3936			
9664	1932.8	3865.6	9723	1944.6	3889.2	9782	1956.4	3912.8	9841	1968.2	3936.4			
9665	1933	3866	9724	1944.8	3889.6	9783	1956.6	3913.2	9842	1968.4	3936.8			
9666	1933.2	3866.4	9725	1945	3890	9784	1956.8	3913.6	9843	1968.6	3937.2			
9667	1933.4	3866.8	9726	1945.2	3890.4	9785	1957	3914	9844	1968.8	3937.6			
9668	1933.6	3867.2	9727	1945.4	3890.8	9786	1957.2	3914.4	9845	1969	3938			
9669	1933.8	3867.6	9728	1945.6	3891.2	9787	1957.4	3914.8	9846	1969.2	3938.4			
9670	1934	3868	9729	1945.8	3891.6	9788	1957.6	3915.2	9847	1969.4	3938.8			

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Glossary

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A/D-converter	Analogue-to-digital converter
ACI	Accessory Control Interface
ADC	Analogue-to-digital converter
ADSP	Application DPS (expected to run high level tasks)
AGC	Automatic gain control (maintains volume)
ALS	Ambient light sensor
AMSL	After Market Service Leader
ARM	Advanced RISC Machines
ARPU	Average revenue per user (per month or per year)
ASIC	Application Specific Integrated Circuit
ASIP	Application Specific Interface Protector
B2B	Board to board, connector between PWB and UI board
BA	Board Assembly
BB	Baseband
BC02	Bluetooth module made by CSR
BIQUAD	Bi-quadratic (type of filter function)
BSI	Battery Size Indicator
BT	Bluetooth
CBus	MCU controlled serial bus connected to UPP_WD2, UEME and Zocus
CCP	Compact Camera Port
CDMA	Code division multiple access
CDSP	Cellular DSP (expected to run at low levels)
CLDC	Connected limited device configuration
CMOS	Complimentary metal-oxide semiconductor circuit (low power consumption)
COF	Chip on Foil
COG	Chip on Glass
CPU	Central Processing Unit
CSD	Circuit-switched data
CSR	Cambridge silicon radio
CSTN	Colour Super Twisted Nematic
CTSI	Clock Timing Sleep and interrupt block of Tiku
CW	Continuous wave
D/A-converter	Digital-to-analogue converter
DAC	Digital-to-analogue converter
DBI	Digital Battery Interface
DBus	DSP controlled serial bus connected between UPP_WD2 and Helgo

DCT-4	Digital Core Technology
DMA	Direct memory access
DP	Data Package
DPLL	Digital Phase Locked Loop
DSP	Digital Signal Processor
DTM	Dual Transfer Mode
DtoS	Differential to Single ended
EDGE	Enhanced data rates for global/GSM evolution
EGSM	Extended GSM
EM	Energy management
EMC	Electromagnetic compatibility
EMI	Electromagnetic interference
ESD	Electrostatic discharge
FCI	Functional cover interface
FPS	Flash Programming Tool
FR	Full rate
FSTN	Film compensated super twisted nematic
GMSK	Gaussian Minimum Shift Keying
GND	Ground, conductive mass
GPIB	General-purpose interface bus
GPRS	General Packet Radio Service
GSM	Group Special Mobile/Global System for Mobile communication
HSDPA	High-speed downlink packet access
HF	Hands free
HFCM	Handsfree Common
HS	Handset
HSCSD	High speed circuit switched data (data transmission connection faster than GSM)
HW	Hardware
I/O	Input/Output
IBAT	Battery current
IC	Integrated circuit
ICHAR	Charger current
IF	Interface
IHF	Integrated hands free
IMEI	International Mobile Equipment Identity
IR	Infrared

IrDA	Infrared Data Association
ISA	Intelligent software architecture
JPEG/JPG	Joint Photographic Experts Group
LCD	Liquid Crystal Display
LDO	Low Drop Out
LED	Light-emitting diode
LPRF	Low Power Radio Frequency
MCU	Micro Controller Unit (microprocessor)
MCU	Multiport control unit
MIC, mic	Microphone
MIDP	Mobile Information Device Profile
MIN	Mobile identification number
MIPS	Million instructions per second
MMC	Multimedia card
MMS	Multimedia messaging service
MTP	Multipoint-to-point connection
NFC	Near field communication
NTC	Negative temperature coefficient, temperature sensitive resistor used as a temperature sensor
OMA	Object management architecture
OMAP	Operations, maintenance, and administration part
Opamp	Operational Amplifier
PA	Power amplifier
PDA	Pocket Data Application
PDA	Personal digital assistant
PDRAM	Program/Data RAM (on chip in Tiku)
Phoenix	Software tool of DCT4.x and BB5
PIM	Personal Information Management
PLL	Phase locked loop
PM	(Phone) Permanent memory
PUP	General Purpose IO (PIO), USARTS and Pulse Width Modulators
PURX	Power-up reset
PWB	Printed Wiring Board
PWM	Pulse width modulation
RC-filter	Resistance-Capacitance filter
RF	Radio Frequency

RF PopPort™	Reduced function PopPort™ interface
RFBUS	Serial control Bus For RF
RSK	Right Soft Key
RS-MMC	Reduced size Multimedia Card
RSS	Web content Syndication Format
RSSI	Receiving signal strength indicator
RST	Reset Switch
RTC	Real Time Clock (provides date and time)
RX	Radio Receiver
SARAM	Single Access RAM
SAW filter	Surface Acoustic Wave filter
SDRAM	Synchronous Dynamic Random Access Memory
SID	Security ID
SIM	Subscriber Identity Module
SMPS	Switched Mode Power Supply
SNR	Signal-to-noise ratio
SPR	Standard Product requirements
SRAM	Static random access memory
STI	Serial Trace Interface
SW	Software
SWIM	Subscriber/Wallet Identification Module
TCP/IP	Transmission control protocol/Internet protocol
TCXO	Temperature controlled Oscillator
Tiku	Finnish for Chip, Successor of the UPP
TX	Radio Transmitter
UART	Universal asynchronous receiver/transmitter
UEME	Universal Energy Management chip (Enhanced version)
UEMEK	See UEME
UI	User Interface
UPnP	Universal Plug and Play
UPP	Universal Phone Processor
UPP_WD2	Communicator version of DCT4 system ASIC
USB	Universal Serial Bus
VBAT	Battery voltage
VCHAR	Charger voltage
VCO	Voltage controlled oscillator

VCTCXO	Voltage Controlled Temperature Compensated Crystal Oscillator
VCXO	Voltage Controlled Crystal Oscillator
VF	View Finder
Vp-p	Peak-to-peak voltage
VSIM	SIM voltage
WAP	Wireless application protocol
WCDMA	Wideband code division multiple access
WD	Watchdog
WLAN	Wireless local area network
XHTML	Extensible hypertext markup language
Zocus	Current sensor (used to monitor the current flow to and from the battery)

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